ICT IN THE PRIMARY CLASSROOM:
ENHANCING STUDENT LEARNING

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ABBREVIATIONS AND TERMS

*ICT, information and communication tools, computer technologies, and computer-based tools:* Used interchangeably and refer to computers and associated hardware and software including desktop publishing software, digital software, and interactive learning software.

*Inclusiveness:* Teaching practice that pays attention to excellence and equity, in recognition of the range of physical, intellectual and behavioural functioning needs of students, including those concerning giftedness, that teachers are required to accommodate in classrooms of today.
Abstract

Educational research indicates that the use of computers and associated technologies as tools in regular classroom practice may have many positive effects on student learning and attitudes. However, for successful integration of such tools to occur, critical changes are often necessary in the way schools and classrooms function. This case study was therefore undertaken to investigate the integration of Information and Communication Technologies (ICT) as teaching and learning tools in English and Mathematics classes, and to examine classroom management, organizational and pedagogical issues associated with the integration of ICT tools. A cohort comprising 72 Year-4 students and two Year-4 teachers from one primary school participated in the study.

Both quantitative and qualitative methodologies were used to collect the data. The final analysis revealed a significant improvement in English and Mathematics achievement outcomes of students who had used ICT tools compared with students who had used solely traditional instruction. In addition, there were positive changes in attitudes towards learning in those students who had used ICT indicating that ICT tools have the potential to influence students’ perceptions on learning. Although the potential of ICT to enhance learning is acknowledged in this study, it also identifies the issues concerning its use. Examination of the curricula and pedagogical implications of the use of ICT in the Year-4 setting suggests that the effectiveness of the tools may be as much an implementation issue as a matter of instructional design.
CHAPTER ONE

The Problem

1.1 Introduction

The educational benefits of computers and associated information and communication technologies (ICT) have engaged the attention of educationalists over several decades and it is well documented that these tools, when integrated within a carefully planned instructional framework, have the potential to support the teaching and learning process. While the educational potential of ICT has been widely acknowledged and educational reform efforts have resulted in innovative applications of the tools, few examples can be found of large scale and sustained use of the tools in teaching practice (Bruce & Lunsford, 2003; Burns & Bozeman, 1981; Collins, 1991; Cotton, 1996; Cuban, 1986; 2001; Ford, Poe & Cox, 1993; Frank, 1988; King, 1997; Kleinman, Humphrey & Lindsay, 1981; Millman, 1984; Papert, 1993; Riedesel & Clements, 1985; Wheatley, 2004).

Endeavouring to seek answers to several questions associated with the integration of ICT in classrooms, this researcher undertook an evaluative study in 1999, upon invitation by the Catholic Education Office (CEO) in the diocese of Parramatta. The study called for an evaluation of the educational potential of SuccessMaker, a computer-based Integrated Learning System (ILS). The project, commissioned by the CEO, was undertaken in a Year-6 setting in a CEO primary school to determine whether the educational benefits of SuccessMaker could be realized within that context. Implicit within the approach was a clear desire by the CEO to generate information on the effectiveness of the ILS on student learning, and on student attitudes towards learning. Based on the outcomes of that study the CEO proposed to make practical decisions pertinent to the use of computer-based tools in diocesan educational contexts.
On completion of that study, research findings were presented to the CEO in a report; *An Evaluation of SuccessMaker, An Integrated Learning System: Final Report* (Godfrey, 1999). The report articulated the educational merits of the tool in relation to student learning outcomes and attitudes, and highlighted a number of classroom issues associated with the use of the ILS. Within the context of that study however, *SuccessMaker* was used by teacher and student participants as a separate strategy, and mainly as a drill-and-practice tool. Goals and objectives during student interactions with *SuccessMaker* were determined by the software and did not match those of the Year-6 classroom curriculum.

Findings from the *SuccessMaker* study raised several issues that warranted further investigation. In addition, professional experience, and personal reflection as a practicing teacher over several years prompted this researcher to strive to gain a deeper insight into the potential of ICT as teaching and learning tools within settings that combined ICT, social constructivism and inclusiveness. In seeking answers to questions concerning student achievement, student attitudes, and teacher pedagogy within that context, there was also a desire to disseminate information gained among teachers who were grappling with similar issues.

### 1.2 Context

This study was conducted in one co-educational Catholic Education Office (CEO) primary school in the Diocese of Parramatta in Western Sydney, with a population of approximately 500 students. Participants invited comprised 72 Year-4 students, 36 boys and 36 girls, aged between 9 and 10 years; and two Year-4 teachers.

At the time the study was proposed, the school was in the process of examining a range of models that could potentially be used to support the integration of ICT in Year-4 classrooms. Implicit within the approach was a desire by the school principal to use the
outcomes of this study to guide decisions in relation to computer access for Year-4 students. The study would also guide the school in decisions pertaining to the purchase of hardware and software for teachers and students in the Year-4 classrooms.

1.2.1 Selection of ICT Tools

The study set out to investigate ICT tools that could be realistically integrated into the Year-4 instructional framework, within a model that could be sustained on completion of the study and beyond. To this effect the researcher held discussions with the school principal and the Year-4 teachers regarding the selection of ICT tools to be applied. During those discussions a number of factors were considered, taking into account the needs of the students, the needs of the teachers, and the resources available within the school context.

**Student needs.** Firstly, to accommodate the range of students’ learning needs, software features would have to be easy to manipulate. Since some students would require more time and extended practice to understand and master concepts, software would need to contain elements that could motivate them and keep them engaged (Hickson, Blackman & Reis, 1995). In addition, students would need to be able to access software either individually or in groups to reinforce their understanding of concepts, to gain specific skills, to enhance representations of their learning, and to engage in collaborative projects.

**Teacher needs.** Secondly, the literature (Fitzgerald, Hughes & Fitzgerald, 1996) has noted that teachers can become overwhelmed with the task of designing an instructional framework that integrates ICT as part of a whole approach. Further, to engage in effectively planning and implementing an integrated approach requires time and so can increase teacher workload. Those issues were evident in previous activities associated with the integration of ICT undertaken by the researcher (Godfrey, 1999). From those perspectives the tools selected and the approach applied would have to emphasise simplicity, flexibility and adaptability in terms of planning and day-to-day implementation.
Available resources. Thirdly, hardware and software resources at the school were limited, and restrictions on site licences on software for educational purposes had to be considered.

In addition to the factors listed, a number of theoretical perspectives on the educational application of computers were taken into account. Chief among those were the concepts put forward by Maddux, Johnson and Willis (1999) who classified educational computer programs into two types; Type 1 software and Type 2 software.

The term Type 1 software had been used by Maddux et al. (1999) to describe drill-and-practice tools or tutorial software, designed to make it easier, quicker or more efficient for teachers to teach topics in the traditional manner. This type of software is usually aimed at enabling students to develop and practice important skills and concepts and to become familiar with skills and concepts to be used when pursuing higher order activities. While there are very good examples of Type 1 software this tool should be sparingly applied and is best used to teach discrete skills or to release the teacher from mundane and repetitive teaching tasks so that time and effort can be devoted to more important complex and creative teaching (Maddux et al., 1999).

The term Type 2 software had been used to describe software that can make new and better ways of teaching available. Examples of this type of tool include word processing, multimedia and digital software, spreadsheets and databases, simulations and problem solving software. Among the characteristics common to Type 2 software are the capability of the tools to stimulate a high level of intellectual user involvement, user control, user interaction and input, and a focus on completing creative tasks instead of rote tasks (Maddux et al., 1999).

To design and implement a balanced and successful program that integrates ICT, educationalists (Maddux et al., 1999) have recommended that both types of software be
applied in teaching programs. Even so it is not the software but the manner in which the tools are integrated within the instructional framework that will determine their effectiveness or lack of effectiveness. In attempting to bring together the theoretical perspectives on the value of educational software and how they could best be applied to suit the needs of students and teachers a decision was made to select and apply both types of software. Fig 1.2.1 lists the software and hardware used, and is followed by a description of the specific tools applied in the study.

<table>
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<td>Interactive</td>
<td>Writing and publishing software,</td>
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<td>learning software</td>
<td>multimedia &amp; digital tools</td>
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<tr>
<td>o Reading for Literacy-4</td>
<td>o MS Word</td>
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<td>o Computer Classroom for Maths Level-4</td>
<td>o MS PowerPoint</td>
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**Hardware resources:**
- o Six Personal computers
- o Printer
- o Digital camera

*Fig 1.2.1 ICT Tools selected*

**Type 1 Software:** *Reading for Literacy-4*, presented by Thomson Nelson and Nightingale Software, contains interactive multimedia activities for reading comprehension and reading vocabulary that are presented in 27 units. On-screen activities address reading skills within a comprehensive range of text types that can be selected by teachers to target and treat specific reading skills. The CD also contains a set of worksheets that are useful for reinforcing concepts through pencil and paper tasks. Students may access the software for individual work or for paired activities. A printed certificate provides students with positive reinforcement. Simple, clear and uncluttered screens are evident with several inviting and attractive graphic characters that motivate and assist students as they progress through the activities.

**Computer Classroom for Maths Level-4,** presented by Thomson Nelson and Nightingale Software, contains interactive Maths activities that can be selected by teachers to support students’ efforts to reinforce key learning skills or to assist students’ in their
understanding of mathematical concepts. *Computer Classroom for Maths* was considered appropriate because the software has been implemented with a consistent interface, resulting in a familiar and predictable product that is easy to use, particularly for slower learners.

**Type 2 Software:** *Writing and publishing software, multimedia and digital tools* were selected because they are open-ended and can be flexibly applied by the teacher within an integrated instructional framework, and within a social constructivist context. The value of word processing and writing tools has been widely acknowledged (Cotton, 1996; Dowling, 1999; Robyler & Edwards, 2000). The functions of a word processor can support a range of different writing strategies and styles and take the drudgery out of composing, revising and processing text. As a result, writing can become a pleasurable and satisfying activity, particularly for the reluctant writer. Using the features of a word processor, students can tackle writing tasks one step at a time, planning, organizing and composing in non-linear format, and editing words and ideas until the desired effect is achieved (Dowling, 1999; Robyler & Edwards, 2000).

*Multimedia* refers to the integration of different modes of representation within a computer-based document ranging from text to different forms of media including graphics, diagrams photographs, sound and animation. *PowerPoint* is just one example found among an array of multimedia authoring tools currently available that can be used to develop and enhance individual expression of ideas in a variety of ways through the integration of text, graphics, sound and animation.

*Digital cameras and editing software*, give students opportunities to photographically record field trips and practical activities, and to add greater description and unique perspectives to their representations. Such description, insight and individuality would be difficult to convey within a single media format. By viewing their digital images, students have opportunities to review their work, reflect on their experiences and reinforce their learning. The flexible capabilities of multimedia and digital software
make it possible for students to combine and edit textual and multimedia material and re-arrange their ideas and sequencing of ideas (Bottge & Hasselbring, 1993).

1.3 Timeline

The study took place over four years. In Year One, a number of preliminary procedures were undertaken. An area of focus was identified and a framework and timeline were devised for the study. The researcher examined an extensive body of research literature in relation to the use of ICT in classrooms and formulated the research questions. During this time, the researcher developed expertise in the use of software as educational tools. The researcher also visited local schools to observe the manner in which computers and software were being applied in classrooms to enhance teaching and learning.

In Year Two, the researcher examined research methodologies and data collection instruments, and continued to develop the literature review. A primary school was located and discussions were held with the school principal in relation to the length of the proposed study, the procedures involved and the ICT tools to be used. Following those discussions, an application for ethics clearance was made to the Human Ethics Review Committee at the UWS Research Office. Upon obtaining ethics clearance, the researcher invited the school to participate, and discussions were held with the principal and the teachers in relation to the format and procedures of the proposed study.

In Year Three, research procedures were conducted across four phases (Fig 3.3). Phase One commenced in February 2001. The Year-4 students were invited to participate in the study, and parents were informed of the procedures involved. Permission was also obtained from parents of student participants and from administrative authorities. Participating teachers assigned student participants to treatment and control groups, pre-tests were administered to students in both treatment and control groups, as part of
quantitative methodology procedures. The researcher worked collaboratively with teacher participants to plan a program within which ICT would be integrated and assisted teachers in learning to use the software to be applied. From that point the researcher stepped back and took on the role of an observer. Phase Two took place during Term 1 and Term 2, during which time ICT tools were applied to the treatment group as part of their English and Mathematics instruction. Data were collected from student and teacher participants using qualitative methodology. During Phase Three, post-tests were conducted for quantitative analysis. Qualitative data collection procedures took place in Phase Four, in the final week of Term 2. At the end of this phase students and teachers were debriefed and a summary of preliminary research findings was presented to the school principal, teachers, students and parents.

In Year Four, a more detailed analysis was conducted on all quantitative and qualitative data collected during the investigation. Work was then commenced on this thesis.

1.4 Purpose

The overall purpose of the study was to evaluate the effectiveness of ICT on student achievement in English and Mathematics in comparison with the use of traditional classroom instruction alone. The study also set out to examine the impact of ICT on the classroom environment and to highlight the management, organizational and pedagogical issues associated with the use of ICT in the Year-4 classrooms. It was ascertained that this research would provide primary schools and teachers with valuable information concerning the benefits and the issues associated with the integration of ICT tools into traditional instruction, in bringing together the features of social constructivism and inclusiveness.
1.5 Research Questions

The issues to be addressed within the framework of the study were formalised into four pertinent questions. Those questions were:

1. Does the use of ICT tools by Year-4 students in the treatment group result in higher achievement outcomes in English and Mathematics, compared with achievement outcomes of Year-4 students who receive traditional classroom instruction alone?

2. Does the use of ICT tools by Year-4 students in the treatment group improve their attitudes towards learning and towards themselves as learners, compared with attitudes of Year-4 students who receive traditional classroom instruction alone?

3. What are the classroom management, organisational, and pedagogical issues associated with the use of ICT from student and teacher perspectives?

4. Do teachers need new skills and altered attitudes to be empowered to integrate ICT effectively in their classrooms?

To answer the research questions, this thesis is organised in the following manner; Chapter Two reviews the literature in relation to the use of computers and associated technologies in schools from the 1920s to the present. The effects of computer technologies on student achievement outcomes and attitudes to learning is examined with reference to the research literature. Classroom management, organization and pedagogical issues associated with the use of ICT, and teacher skills and attitudes, and supports required to empower them to make the pedagogical changes in order to integrate ICT to enhance teaching and learning are also explored. Chapter Three describes the design and methodologies applied to answer the questions pertinent to the study. Chapter Four presents the quantitative and qualitative outcomes of the study.
Chapter Five contains a discussion of findings. Chapter Six concludes the study, with recommendations for the successful integration of ICT with an emphasis upon enriching the existing curriculum and enhancing learning experiences for all students in the inclusive classroom.

1.6 Limitations
The interpretation of the data needs to take into account the limitations associated with this study. Those limitations are listed below.

Small group size. The study was conducted in one primary school. Further, the school principal directed that specific teachers and students be involved in the study. To increase the sample size the study was spread across two class groups. To minimise the impact of using two class groups and two teachers, post-tests were administered to a second control group, drawn from a Year-4 class that had not participated in pre-tests. Post-test outcomes of that second control group were compared with post-test outcomes of the participant control group, to exclude pre-test effects and to increase validity.

Short application period. This was not a longitudinal study. Further, the timeline of the project required that research conducted at the school be completed within two school terms. However, by implementing the investigation over two terms it was conducted as a natural part of the teaching and learning process.

Limited choice of software. Due to minimal resources at the school and restrictions on site licences for educational purposes, the choice of software was limited. From a teacher perspective this meant that they were able to evaluate tools that were available in a typical classroom situation and build them into the instructional design.
Access to students. In the current climate of high ethical expectations and increased child protection legislation, obtaining access to students is limited. Those restrictions narrowed the choice of schools.

Researcher bias. To minimize bias the researcher maintained a detached position during implementation of the investigation, visiting the school twice per week to conduct observation and to chair weekly teacher meetings. However, as a practicing school teacher conducting research, the researcher's own beliefs, attitudes and values may be apparent within this thesis.

This chapter contained the context and the significance of the study. The following chapter will review the literature in relation to the use of computers and associated technologies in schools (ICT), and the issues surrounding the use of ICT as teaching and learning tools.
CHAPTER TWO

Review of the Literature

2.1 Introduction

From Sidney Pressey's programmed instruction machine of the 1920s to the Information and Communications Technology (ICT) tools of today, educationalists have, over several decades, attempted to promote the use of computers and related technologies to enhance the teaching and learning process. While there is a paucity of research on the use of computer technologies in schools much of the available literature is based on overseas examples. This study set out to evaluate the potential of information and communication tools in an Australian context.

To that degree, the four main sections of the Literature Review are pertinent to the focus questions of the research study. Section One includes a brief historical perspective of the use of computers and associated technologies in schools from the 1920s to the present. Section Two investigates the effectiveness of ICT on student achievement outcomes and attitudes towards learning. Section Three examines classroom management, organization and pedagogical issues associated with ICT. Section Four explores issues associated with empowering teachers to acquire the skills and make the attitudinal and pedagogical changes required to integrate ICT effectively to enhance teaching and learning.

2.2 Historical Perspectives

Interest in the instructional potential of machines began in the 1920s with the work of Sidney Pressey (1926; 1927). Objective tests were becoming common in schools and Pressey, who developed a machine that could be used to administer multiple-choice test items, soon realised the teaching potential of the machine. Using the machine students
were required to work through a given test a number of times, attempting to complete the test with fewer errors on each attempt. While the teaching machine produced some interest among educationalists at the time it was not widely applied in schools (Maddux Johnson & Willis, 2001).

Hybrid machines, part mechanical and part electronic, were built between 1930 and 1945 but did not gain popularity. This was because computer theorists required a system of logic for a machine that could deal with two states: on and off. The advance from obtuse theory to electric circuits was made in 1937, when George Shannon expressed Boolean logic with electrically operated mechanical relays, leading to the invention of the modern electronic computer in the 1940s (Reid, 1985). However, these machines were colossal in size because their major components were vacuum tubes. This changed when the development of the transistor in the late 1940s revolutionised electronics. Transistors used solid-state semiconductor components making computers more practical and dependable, and reducing their size and power requirements. Further advances in semiconductor technology in 1947 produced even smaller components with greater capabilities (Maddux, et al., 2001).

The invention of the integrated circuit in the 1950s resulted in the microcomputer, a development that made it possible for computers to be purchased by individuals and by schools. After more than 30 years since Pressey’s first experiments with his teaching machine there was a renewed surge of interest in the instructional capabilities of the computer (Maddux et al., 2001). During this time Skinner, one of the founders of behaviourism, developed a machine for programmed instruction (Skinner, 1958; 1986). Programmed instruction divides material into small units of information called frames and leads the user through instructional material in the same sequence. Skinner believed his machine could be as effective as a good private tutor (Heinich, Molenda, Russell & Smaldino, 2002).

Although perceived to be effective from a behavioural perspective, programmed instruction did not gain lasting acceptance in schools and was strongly opposed in the
mid-1960s (Maddux et al., 2001). Skinner (1986) stated that the rejection of behaviourism and the fostering of constructivism contributed to that failure. Constructivists, on the other hand, argued that programmed instruction failed because it was boring and repetitive, used multiple-choice tests of factual information, and it was debatable whether students could use the information gained in a meaningful way (Heinich et al., 2002).

During the 1960s there were a number of developments in the instructional use of computers in schools. Computers were being used, for example, in computer-assisted instruction (CAI) to teach Maths skills within a drill-and-practice format developed by Suppes and Morningstar (Heinich et al., 2002). Branching programmed instruction was also being used to cater for individual differences, and structured tutoring and programmed teaching were being used for large-group settings (Heinich et al., 2002). Compared with earlier programmed instruction methods the new formats provided learners with opportunities for active participation, practice and feedback, and self pacing. However learning in this way was found to be tedious, particularly when instructional design did not include meaningful contexts, transfer of knowledge and skills, and opportunities for social interaction in classrooms (Heinich et al., 2002).

Computers of the 1970s were still being predominantly used in classrooms as media for conveying information and for tutoring; and student interaction was restricted to simply pressing a key or responding to queries posed by the machines. Researchers, Cohen and Spenciner (1993) reported that this restricted use was partly due to the limited capabilities of computer programs of the period, and the limited range of programs available for educational use. Despite this, educators believed that instruction could become more productive if computers were to take over some of the teacher’s traditional role (Jonassen, Carr & Yueh, 1998).

At this time computer-based resources were classified by educationalists, into three categories; computer-assisted instruction (CAI) which included drill-and-practice,
tutorial or simulation software, computer-managed instruction (CMI) comprising software used for testing, record-keeping and reporting, and other software, a term used for all other software programs outside the CAI and CMI categories (Maddux et al., 2001).

In the 1980s, computer-based technologies were referred to as Information and Communication Technologies (ICT) and were being used in schools for computer-based instruction (CBI), computer-based learning (CBL), or computer-assisted learning (CAL). Educators were now beginning to realize that the tools could, potentially, be used to implement changes in teaching practice and open up new opportunities to make learning more exciting for students (Burns & Bozeman, 1981; Edwards, Norton, Taylor, Wies & Van Dusseldorp, 1975; Maddux et al., 2001; Robyler, 2004). During that decade the concept of computer literacy also began to emerge in educational contexts in the United States. Formal reports and recommendations on computer literacy were published by a number of educational commissions in the US including the National Commission on Excellence in Education, the National Council of Supervisors of Mathematics, the National Council of Teachers of Mathematics, and the National Council for Social Studies (Riedesel & Clements, 1985).

By this time educators were convinced that computers should have a place in the classroom, however, there was controversy surrounding the concept of computer literacy. Several issues emerged including the definition of the term, the kinds of knowledge and skills involved, and the importance of the knowledge and skills involved. Discussions continued over the next five years, and producing little consensus, shifted to whether computer literacy should be focused on learning about computers or on learning how to use computers. While some advocates of computer literacy supported the notion that students should be taught to program computers, others believed programming to be a waste of time and argued that students should be taught to use programs written by others to assist in their learning (Maddux et al., 2001; Riedesel & Clements, 1985).
Up to the late 1980s computer use in schools had focused on efforts to improve student achievement outcomes. In the 1990s the pedagogical dimensions of computers and related tools began to receive increasing attention. Those dimensions were defined by Reeves (in Lidstone & Lucas, 1998) as capabilities of technology that can initiate powerful instructional interactions, monitor the learning process, accommodate individual differences, and promote social constructivism. The instruction machines of the early 1920s had evolved into technological tools of the new millennium, with potential to provide a range of interactive and multimedia opportunities not previously available in classrooms.

Computers and related technologies have been described, in contemporary literature, as powerful information and communication tools (ICT) that can be used to empower teachers and enable them to enhance the teaching and learning process. It has become possible to use computer software within instructional frameworks to address diverse learning needs, diverse learning styles and multiple intelligences. Further, the tools can be used to promote critical thinking, and support and sustain learner engagement within social constructivist learning contexts and consequently, enhance student achievement outcomes and attitudes.

Fig 2.2 Computers and associated technologies in schools since 1920 ( Adapted from Godfrey, 2005)
2.3 Effects of ICT on Student Achievement

The effects of computers and associated technologies on student achievement had engaged the attention of educationalists ever since the introduction of computers in schools. One of the earliest reviews of the effects of computer-assisted learning on student achievement was conducted by Edwards, Norton, Taylor, Wies and Van Dusseldrop (1975). The review revealed that instructional frameworks integrating computer technology were more effective than those implementing solely traditional methods. Vinsonhaler and Bass (1994) also conducted a similar review on computer-assisted learning. As part of that undertaking, nine studies conducted between 1966 and 1975 explored the use of computers for drill-and-practice in Mathematics and Language Arts in elementary schools (Khalili, 1994). Findings in that review also concluded that the use of computers increased positive effects on students’ achievement outcomes than did traditional instruction alone, when measured by improved scores on standardised tests.

In the early 1980s researchers began to embrace the meta-analysis technique in an attempt to synthesise the findings of a number of diverse studies. A meta-analysis of forty studies, undertaken by Burns and Bozeman (1981) on the effects of computers in primary and secondary schools concluded that computer-assisted learning (CAL) was superior to traditional instruction alone. Likewise, a meta-analysis conducted by Kulik, Bangert and Williams (1983), focused on research in schools between 1970 and 1983. Results from the meta-analysis indicated that students who used CAL generally learned more, required less instructional time to grasp new concepts and remembered concepts for longer periods. It should be noted that meta-analyses undertaken during that period synthesised studies that involved the use of mainframes and not the personal computers of the present times.

Computer assisted learning in drill-and-practice contexts have been described as a safe place for learning. Such contexts have been said to offer students patience, privacy, safety from peer ridicule and an atmosphere where ideas are treated with respect and
judgement is temporarily suspended (Kleinman, Humphrey & Lindsay, 1981). Two studies, investigating the holding power of a four-week drill-and-practice course in Mathematics in Third-grade and Fourth-grade classrooms, were undertaken by Kleinman, Humphrey and Lindsay in 1981, and by Millman in 1984 (Ford, Poe & Cox, 1993). Findings in both studies revealed that students voluntarily remained longer on task and completed more Maths problems on the computer than they did at comparable paper and pencil tasks (Ford, Poe & Cox, 1993).

Curiosity and interest on the effects of computer technologies on achievement outcomes continued over the years. A two-year investigation by Funkhouser (1993) involving 40 high school student participants from Year-8 and Year-9 classrooms, revealed significant gains in student tests scores and problem solving ability in Mathematics after the application of the software titles; Building Perspective and Blockers and Finders. Funkhouser’s findings also revealed an improvement in students’ attitudes to learning Mathematics (Funkhouser, 1993).

Contemporary literature has expanded our understandings of the effects of computer-related technologies on student achievement outcomes even further. In 1996 Cotton (1996) analysed 59 research reports on the effects of computer assisted learning (CAL) on American, Israeli and Canadian students in Mathematics, Language Arts, Reading, Science, Health Studies and Social Studies. Cotton’s review concluded that when CAL was used within a well-designed and carefully implemented framework, the approach produced a significant improvement in students' final examination scores, increased their learning rate and their learning retention (Cotton, 1996).

2.4 Effects of ICT on Student Attitudes

While learning outcomes are important in educational programs, attitudes to learning are equally important because student attitudes reflect their academic progress and achievement. The usefulness of computers to enhance the quality of learning environments and, consequently, improve student attitudes towards learning has been well supported by researchers. Funkhouser (1993) demonstrated this in a two-year study
in which Year-8 and Year-9 students used Maths problem solving software. Funkhouser’s findings concluded that students developed positive attitudes about themselves as learners of Mathematics, and about Mathematics as a discipline. Findings in that study also reported that students worked harder, enjoyed Mathematics more, and were willing to do well in the subject after they had used computers as part of their instruction (Funkhouser, 1993).

While several studies had reported positive effects of computer technologies on student attitudes, Croy, Cook and Green (1993) argued that there was a lack of evidence that children exposed to machine interaction over long periods of time developed a range of knowledge, skills and values. Further, that computers could have a negative influence on student and teacher interaction in the classroom. Contrary to those views, however, it is well documented in studies focusing on the social aspects of ICT that computer technologies can be used as a means of stimulating student-teacher interaction and student-student interaction, resulting in positive gains in attitudes (Little, 1987; Yelland, Richard & Russell, 1997). Those studies reported that, far from inhibiting students’ interactions with the teacher and with each other, when used appropriately computers can in fact, enhance them.

The wider effects of computer use encompass positive changes in student behaviour and attitudes, and modification of the instructional process within and outside the classroom, serving as reminders that the tools have effects that transcend the immediate consequences for learning (Little, 1987; Yelland, Richard & Russell, 1997). It has also been argued that interactive and flexible capabilities of Information and Communication Technologies (ICT) of today have the potential to promote interactive learning, enabling students to work with the computer and with each other in social-constructivist contexts (Shaw, 1996). Within such contexts, it has been noted that ICT activities can be used to sustain motivation and engagement, and offer a range of learning opportunities not previously available in learning environments.
Several studies across educational levels and learning areas demonstrate that when computer technologies are integrated within a well-designed teaching program and supported by teachers, the tools have the potential to enhance student achievement outcomes. Research also indicates that students generally learn more, remember longer, and require less instructional time, suggesting that the use of computer technologies is more effective than traditional instruction alone. It is also reported that the use of ICT can lead to qualitative improvements in the classroom environment and a sense of student ownership of the learning process (Squires, Morton & Brown, 1997). Finally, it has been demonstrated that ICT can have desirable effects on student attitudes to learning within social constructivist contexts, leading to sustained and meaningful engagement for students, and improve motivation and enthusiasm for learning.

2.5 Challenges for Schools

While it is acknowledged that ICT can be used to reshape the educational process, the convergence of the tools presents schools with many challenges, opening up much discussion and debate. School education has, in general, had difficulty in meeting the challenge of major shifts related to ICT use. As computers have become more commonplace in classrooms, it would appear on the surface that schools have taken on this particular challenge more seriously (Cuban, 2001). In reality however, schools have remained embedded in a world of paper and computers have remained on the periphery, used mainly for drill-and-practice, word processing, or as rewards for students (Cuban, 2001; Heinich et al., 2002; Maddux et al., 2001).

Up to the 1990s the focus was on integrating computers and related technologies into the existing school system, one described by Collins (1991) particularly in the US context, as a self-sustaining, interlocking structure of age-graded schools dominated by multiple-choice testing, curriculum content, and lecture and recitation teaching methods that resisted the use of computer technology. Since computers undermine lecture and recitation teaching methods and promote the student as a self-directed learner, they would not fit the prevailing structure, and would be squeezed out by it. Collins (1991) contended that if ICT use supported lecture and recitation teaching methods, that use
would be easily assimilated, whereas ICT use that promoted the student as a self-directed learner would not be so easily taken up. Fullam (1997) and Spender (1998), in reinforcing Collins’ views, advocated a re-engineering of outmoded school structures, and a re-modelling of school curriculum. Those researchers predicted that students would require a different set of skills to negotiate learning as new parameters would dictate what was required of them to enable them to function in a future world, and that schools would need to be adaptive and bear relevance to that future world. For systemic change to occur, the focus of change would have to shift from the technology to the people who implement the use of technology; teachers.

2.6 Classroom Management, Organisation and Pedagogy

The extent of the educational benefits of ICT is dependent upon the manner in which teachers manage and organize their classrooms, integrating ICT activities with traditional activities to develop authentic and exciting learning environments within which students can be actively and collaboratively engaged in learning, designing and creating (Morden, 1997). In planning such an approach teachers would have to select appropriate learning experiences within an instructional framework that linked ICT activities with curriculum content. Teachers would also need to include a variety of learning activities both at the computer and away from the computer to provide students with opportunities to develop and demonstrate new skills and understandings in a range of ways.

In implementing the program teachers would need to ensure that students achieve curriculum goals as a result of their interactions with ICT activities through training, scheduling, and monitoring their progress. During implementation teachers would have to intervene when students experienced problems, by modifying the program or applying strategies to support student learning. Following implementation, it would be necessary to evaluate all aspects of the program and reflect on curriculum and pedagogical implications for future planning. In the short term this would doubtlessly impact on teachers’ time, and increase their workload.
Fig 2.6 Integrating ICT in the Inclusive Classroom: Conceptual Framework
2.6.1 Social Constructivism

Contemporary education has seen a shift in the way learning is perceived in classrooms, with an emphasis on the quality of learning experiences for students rather than just quantifiable outcomes (Cuban, 2001; Howell & Nolet, 2000; Newhouse, 2001; Nir-Gal & Klein, 2004; Mann, 2000). Association learning, is described by psychologists including Pavlov, Skinner, Thorndike and Watson (Thomas, 2002) as learning that is akin to habit formation through conditioning which attaches desired responses to specific stimuli that can be utilized in basic forms of learning. However, cognitive restructuring or constructivism through active engagement is the major sought after learning outcome. Defined as the process of constructing and developing new knowledge by modifying and building on existing knowledge, constructivism has assumed great importance in recent years (McInerney, 2002). Constructivism promotes active and sustained engagement in student learning, and when integrated effectively through carefully structured activities, ICT can be used to achieve that goal.

Teaching practice consistent with constructivist thought involves helping students to internalize and reshape new information, and make it their own. Social constructivism, or the construction of shared knowledge in social contexts takes the notion of constructivism a step further, emphasizing the importance of continuing interaction between a student and the student’s social environment (McInerney, 2002). Researchers take the position that within such contexts learning becomes even more meaningful and learner-controlled, and promotes social skills, positive interdependence and individual accountability as students provide each other with corrective information and emotional support (McInerney, 2002; Slavin, 1998). Such learning is of great benefit to students, both in the classroom and in wider contexts.

2.6.2 The Inclusive Classroom

The inclusive classroom is a relatively new teaching and learning context for many practicing teachers. Up to the 1950s children with disabilities, specifically those with
intellectual disabilities, were not expected to attend school and were not recognized as equal participants in the community by some sections of society (Ashman & Elkins, 2005). As a result of extensive lobbying efforts by parent organisations during that decade, state education departments in Australia and New Zealand began initiatives to provide this group of children with a form of education in training centres, and subsequently, educating them in special schools, in special units or in special classes (Ashman & Elkins, 2005). Since the 1950s state education has undergone numerous reviews and restructuring processes in relation to the delivery of education for students with disabilities.

As attitudes towards disability have continued to change, particularly over the last fifteen years, a series of federal legislative actions have resulted in laws and funding initiatives that opened up increased learning opportunities for students with disabilities (Ashman & Elkins, 2005). School policies for equitable access to education for all students began to progress towards inclusive educational practice, and in the 1990s a major change occurred in the delivery of special education services. Instead of being placed in separate schools or classrooms, students with disabilities were being included and supported in mainstream classrooms (Ashman & Elkins, 2005).

The inclusive classroom is a welcome transformation in school education, serving a range of student needs from physical and intellectual needs to those concerning giftedness. However, for teachers working in the inclusive setting it has become necessary to modify curriculum, instruction strategies, and assessment materials to meet a wider spectrum of student needs. This can place a relentless demand on teacher time and workload. In such classrooms ICT tools are useful for providing supports for teachers in their efforts to address the issues of individualization and diversity.

2.6.3 ICT in the Inclusive Classroom

This study set out to investigate ICT tools that can be accessed and adapted by teachers to enhance teaching and learning and to meet diverse student needs in an inclusive setting. There is a paucity of research on ICT tools available for instructional use and the
manner in which they can be applied to address the issues of individualization and diversity. Maddux, Johnson and Willis (1999) classified educational computer programs into two types; *Type 1* software and *Type 2* software.

*Type 1 software* was used to describe drill-and-practice software and tutorial software, tools that were designed to make it easier and more efficient for teachers to teach topics in the traditional manner (Maddux et al. 1999). This type of software is usually aimed at helping students to develop and practice important skills and concepts and become familiar with skills and concepts to be used when they pursue higher order activities. Type 1 software applications generally require less active intellectual involvement by the user relative to that required by Type 2 software applications. The software developer predetermines almost everything that takes place on the screen, including the level of interaction between user and machine. Activities in this type of application are usually aimed at the acquisition of facts by rote memory.

While some educationalists assert that using type 1 applications is not making the best use of ICT resources, others have gone so far as to condemn the use of the tools (O’Brien, 1994). More recent literature, however, tends to be less critical of type 1 software and, instead, takes a balanced view of this type of application. Howell (1998) stated that the criticism leveled in the past was aimed at poorly designed software that was boring and repetitive. Similarly, Robyler and Edwards (2000) acknowledged that this type of software has improved considerably over time, and that when well designed and wisely applied the tools can produce several benefits for students, particularly for low achievers. Those benefits include immediate feedback, motivation, nonjudgemental correction and time saved for teachers who would then have more time to focus on teaching in creative ways.

*Type 2 software* had been used to describe software that can make new and better ways of teaching available in classrooms. Examples of this type of tool includes word processing, multimedia and digital software, spreadsheets, databases, simulations and problem solving software. Type 2 software applications generally stimulate relatively
active intellectual involvement, placing the user in control of almost everything that happens on the screen. The focus shifts from the computer to the students who determine when and how to use the computer to support their efforts to solve problems, collect data, and present information. Students also have greater control over their interaction with the computer. They decide when to use the spell checker, thesaurus and sound and editing features. Type 2 software is usually aimed at accomplishing tasks that require higher order thinking and a high level of creativity.

Type 1 and Type 2 software both play useful roles as teaching and learning tools and educationalists recommend that a balanced and successful educational program should include the use of both types of tools (Maddux et al., 1999). Even so it is not the software, but the manner in which the software tools are integrated within the instructional framework that will determine their effectiveness or lack of effectiveness. In attempting to bring together the theoretical perspectives on educational software, the needs of the students, and the needs of the teachers, both types of tools were selected for this investigation. Type 1 software selected consisted of interactive tools for Literacy and for Maths, and Type 2 software selected consisted of writing and publishing tools, multimedia and digital tools. A more detailed description is contained in Section 1.2.1 and in Fig 1.2.1.

Designing and implementing instructional programs that integrate ICT tools to address diversity requires careful thought and well informed preparation. There are a number of useful learning theories that have been used to address diversity. One such theory is the ‘Concrete-Abstract Continuum’, a concept eloquently put forward by Edgar Dale (1969). That concept, also referred to as the ‘Cone of Experience’, begins with activities that are structured to place the learner as a participant in a real experience. The learner then becomes an observer of the experience presented through a medium, and subsequently progresses to symbolic representation of the experience.

Features of the Concrete-Abstract Continuum had been paralleled in the earlier work of Bruner (1966) who devised a descriptive labeling scheme for instructional activities
embodied in Dale’s theory. While it is true that the greatest volume of information can be presented in the least amount of time through print or speech, if students do not have the prerequisite background experience and knowledge to handle those verbal symbols, the time saved in presentation could be lost in learning. In bringing those ideas together effective learning can occur when methodologies used to drive teaching programs encompass the enactive, iconic and symbolic stages of learning, supported by ICT.

Examples of enactive activities include field trips, investigations, demonstrations and practical activities using concrete materials including cooking, art and craft. Those activities and experiences can then be iconically represented using digital imaging and multimedia tools. Since symbols rarely look or sound like the things they represent, if learners in enactive operational levels of development are forced to use symbols without first creating appropriate iconic images, they may resort to forgetful memorization and may experience great frustration due to poor assimilation and accommodation (Bruner, 1996). In line with Bruner’s theory, iconic representations, created through multimedia and digital imaging, can provide a concrete referent for ideas and information that can be used by students to visually illustrate relationships among elements.

While multimedia and digital imaging tools are useful to support students as they progress from the iconic to the symbolic stage of learning, word processing tools can provide support in the highly symbolic tasks of representation. By combining new information, gained from concrete and iconic experiences, with existing knowledge students can arrive at new understandings, and represent new knowledge and understanding using ICT in a number of ways. Further, word processing and publishing tools have features that offer flexible opportunities for textual and graphic representations. Such representations have been referred to as fluid and easily transformed communication that is closely connected to thinking and speaking (Dowling, 1999).
Used effectively, the vast array of ICT tools of today can support learning by offering opportunities for students to develop critical thinking skills within social constructivist contexts. ICT can also be adapted to address diverse needs and support new and different methods of teaching and learning. This is because the tools can be applied to a number of problems and across an array of human endeavours, enabling the manipulation of environments and events that provide multiple perspectives on complex phenomena (Maddux et al., 2001; Mann, 2000; Ritchie, 1999). In addition, ICT can be used to support strategies for achieving curriculum goals within one area or across several areas simultaneously through a cross-curricular approach (Downes & Fatouros, 1995; Riel, Schwarz & Hitt, 2002; Severinsen, 2004).

While ICT can support teaching and learning, teachers must be in a position to understand how the technologies can be used to enhance learning and be willing to adapt
the tools to their preferred pedagogical approach. Teachers must also be in a position to organise their classrooms, reshape curricula, and plan learning experiences to effectively integrate ICT tools (Cuban, 2001). Since effective learning is about making cognitive connections, effective teaching is about ensuring that those connections create an environment in which learning is active. Within active learning environments ICT can be applied to scaffold students in their efforts to develop and enrich their literacy and numeracy skills.

2.6.3.1 ICT Tools for Scaffolding

*Scaffolding*, within an educational context, describes an intellectual partnership in which a more knowledgeable ‘other’, usually a teacher or a peer, shares the cognitive workload with the learner. The *zone of proximal development* (ZPD) is described, in Vygotsky’s theory (1977), as the distance between abilities displayed by a learner with support or *scaffolding* and abilities displayed independently by the learner. Scaffolding is intended to reduce the processing burden involved in bringing cognitive and metacognitive mechanisms into use during problem solving. Berk (1997) defines scaffolding as a changing quality of support over a teaching session in which the person providing the support adjusts their assistance to fit the student’s current level of performance, providing direct instruction or modeling when a task is new and gradually withdrawing support as the student’s competence increases.

Scaffolding is a necessary component of intellectual development, and when designed to fall within a student’s ZPD, and adjusted to fit current levels of performance creates an intellectual partnership. Such intellectual partnerships have the potential to enable learners to function at a level that transcends the existing limitations of their cognitive system and may serve to change the balance between simply accessing prior knowledge or constructing new knowledge in favour of existing knowledge (Piaget, 1977; Vygotsky, 1978).

While scaffolding is usually envisaged as mediated by more knowledgeable peers or adults, carefully selected ICT tools and activities can also be used to provide scaffolding
through pre-structured content and in-built cognitive supports such as feedback, sequencing, multiple representations of materials and the predictable flow of an activity (Elliott, 1995; Lloyd, 1999). Scaffolding interactions in computer-based contexts can serve to generate the intellectual partnerships referred to by Pea (1987; in Elliott, 1995). In those contexts the cognitive supports within interactive computer technologies can assume a role similar to that of a mentor or teacher, engaging students in activities that provide content and structure, and thus enabling the teacher to concentrate on facilitating other learning activities in the classroom.

An extension of intellectual partnerships occurs in situations wherein a group of students and a teacher, working on a computer-based activity, becomes the setting for the establishment of an *intellectual cooperative*. The notion of *cooperative*, with an emphasis on a mutually supportive interactive and social context, is reflective of Vygotsky's (1978) zone of proximal development. The intellectual cooperative thus provides a situation that elicits the cognitive processes required to attain intended educational objectives through multisensory orientation, interactive and motivational qualities, facility for reinforcement of concepts and the ability to simplify tasks into manageable steps (Vygotsky, 1978).

ICT tools of today can afford sophisticated visual and audio representations, facilitating the manipulation of environments and events to afford multiple perspectives on complex phenomena (King, 1997). Such representations are important for building flexible knowledge assembly and construction processes in complex learning domains (Maddux et al., 2001; Mann, 2000; Ritchie, 1999). Used in combination with traditional activities, interactive features available in word processing, multimedia and digital software, or on CDRoms can be used to scaffold students in their efforts to develop new skills or to reinforce new concepts and skills in literacy and numeracy.

### 2.6.3.2 ICT Tools for Literacy

Literacy has been defined as the ability to speak, listen, view, read, and write effectively, with purpose and confidence within a wide range of contexts (NSW Board of Studies K-
6 English Syllabus Support Document, 1994). Literacy includes the ability to integrate speaking, listening, and critical thinking during reading and writing activities (Australian Language and Literacy Policy, 1991). When carefully implemented, ICT tools can be used to develop and enhance students’ reading and writing skills, and provide opportunities for students to engage in critical thinking, as they speak, listen, explore, understand, record, organize and present written material.

The value of word processing and publishing software as literacy tools has been supported by several researchers. Cotton (1996), who conducted a meta-analysis on 59 research reports on the effects of computer assisted learning, noted that the use of word processing and publishing software, combined with teacher feedback, resulted in positive outcomes in process writing. Benefits documented in Cotton’s meta-analysis included better quality and accuracy in writing, an improved understanding of the writing process, responsiveness to teacher feedback, and enhanced attitudes towards writing tasks (Cotton, 1996).

Cotton’s findings have been supported by Newhouse (1998), who reported that students who had used computers for written tasks demonstrated an improvement in writing skills. Further, the Newhouse report stated that reluctant writers became motivated and remained engaged during writing tasks. Dowling (1999) reinforced findings by Cotton and Newhouse, predicting that the age of interactive television, voice recognition, video conferencing, multimedia and virtual reality would make writing more important than at any other time in history (Dowling, 1999).

**Word processing and publishing software** can support a range of writing strategies and styles, and enable students to communicate in powerful and flexible ways. The editing capabilities of word processing and publishing tools remove the burdensome task of having to undertake re-writes, making writing a pleasurable and satisfying experience even for the reluctant writer (Dowling, 1999). **Multimedia and digital tools** provide writers with opportunities to develop and enhance individual expression and ideas in a variety of ways by integrating text, graphics, animation and sound, consequently, adding greater description and unique perspectives to presentations. Such description, insight
and individuality would be difficult to convey in a single media format (Hickson, Blackman & Reis, 1995; Lindsey, 2000; Olson & Platt, 2000).

When used judiciously and in combination with traditional classroom activities, interactive learning software can also be used to help students to develop skills in reading vocabulary and comprehension, to master correct pronunciation and, as a result, increase student confidence in reading and writing. Thus students can develop and practice important skills and concepts and become familiar with skills and concepts to be used when pursuing higher order activities. The interactive and game-like elements and fun activities found in some good examples of such software can increase motivation and sustain student engagement (Lindsey, 2000; Olson & Platt, 2000). When used within a well-designed instructional framework, this type of software can release the teacher from mundane and repetitive teaching tasks so that time and effort can be devoted to more important complex and creative teaching (Maddux et al., 1999).

2.6.3.3 ICT Tools for Numeracy

As a tool to support numeracy, Type 1 software can assist students in developing concepts, and practicing skills required for engagement in mathematical thinking and problem solving. While there are very good examples of Type 1 software, this tool should be sparingly applied and is best used to teach discrete skills or to release the teacher from repetitive teaching tasks so that teacher time and effort can be devoted to more important tasks and complex and creative teaching (Maddux et al., 1999). Spreadsheet and graphing functions found on Interactive Learning software, for example, can help the learner to manipulate and visualize mathematical concepts, to analyse and organise information, and to represent semantic relationships among ideas.

Multimedia software is one example from a range of Type 2 tools, that can facilitate sophisticated visual and audio representations, enable the manipulation of environments and events, and afford multiple perspectives on complex phenomena (King, 1997). Such representations are important for flexible knowledge assembly and construction processes in complex learning domains (Mann, 2000; Ritchie, 1999). Used flexibly and
in combination with other strategies, it is possible for teachers to adapt Type 1 and Type 2 tools to their particular approach, and to incorporate a number of supporting pedagogical features into instruction to cater for individual differences (Heinich et al., 1999).

2.7 Teacher Skills and Attitudes

Although teachers had been aware of the educational benefits offered by information technology, historically there had been little success in fostering and implementing the innovations in classrooms, and literacy in most classrooms was still being defined exclusively in terms of pen and paper, and paper-based texts (Cuban, 1995; in Schrum, 1997). In classrooms such as those, little or no teacher interaction or direct instruction occurred during computer activities, and computers were used in isolated and solitary activities or as rewards (Maddux et al., 2001). Those views have been supported by researchers (Cuban, 1995; in Schrum, 1997; Mann, 2000) who reported that computers continued to remain ancillary to the pedagogy of traditional instruction in classrooms.

Preliminary findings in an educational research project conducted during the 1990s in the United States by the Office of Technology Assessment (OTA) underscored the need for training in the use of technology for teachers at all levels (Maddux et al., 1997). Findings in the OTA study identified several issues. Practicing teachers lacked the expertise to use computer technology effectively, and resources allocated to instructional computing were inadequate. As a result, computers were being used by teachers for only a small portion of the school day, providing students with fragmented access. In addition, powerful simulation and word processing applications were being underutilized.

Issues similar to those identified by the OTA were attributed to a lack of funding for inservice training for practicing teachers who had experienced very little computer use during their own teacher education courses and in their student-teaching placements. This was because teacher educators at the time did not have the expertise or the resources to
integrate technology into their teacher education courses. Further, teacher educators could not, themselves, access in-service courses on the use of computer based technologies. Computer shortages in colleges of teacher education were also reported as being problematic during that period (Maddux et al., 2001).

Within an Australian context, Newhouse, a professor at Edith Cowan University, conducted a three-year study in a high school in Western Australia in 1998. Participants involved in the Newhouse research project comprised 60 teachers and 350 students from Year-8 through to Year-10. The study investigated the effects of computer assisted learning on students, teachers, the curriculum and the classroom (Newhouse, 1998). The study also observed teacher attitudes towards computers. Findings revealed that there was very little change at the classroom level that could be attributed to computer technology, and teachers supported only a very limited role for computers.

While some teachers demonstrated good levels of computer literacy in the Newhouse study, a lack of operational knowledge was still perceived by many as inhibiting their ability to facilitate the use of computers. Newhouse also concluded that computers were not perceived as critically useful by almost all teachers in the study. This outcome was largely attributed to teachers’ preferred pedagogies, lack of experience with computers, and limited time to experiment with computer applications (Newhouse, 1998). Similar studies on teacher perceptions of computers also reported teachers’ negative attitudes towards the tools, and a reluctance to use computers in their teaching programs. (Cuban, 2001; Means & Olsen, 1994; Peck & Dorricott, 1994; Hannafin & Savenye, 1992; and Bailey & Weippert, 1991; in Newhouse, 1998; Severinsen, 2004; Shamburg, 2004; Yelland, Richardson & Russell, 1997)

Floden, Goertz and O’Day (in Eggenhuizen, 1996) argued that part of the difficulty in the adoption of innovation or reform could relate to teachers themselves, and that the move to implement computer use in the classroom had met with a certain amount of resistance from teachers. It could be argued that this resistance to change was evident
because of the widespread nature of the changes associated with ICT that made it essential for the teacher to learn about the technology and how to use it, change teaching strategies to accommodate the approach, and constantly update skills to keep up with technological change. Floden et al. (in Eggenhuizen, 1996) concluded that not only did teachers perceive computers to be too time consuming, they were reluctant to hand over some of the control to their students.

There had been a perception that students could access computers to learn a skill and that a computer program would take over the teaching of that skill (Gleghorn, 1993; in Ragan & Tillman, 1998). However, learning that occurs in isolation is not sustained in other contexts (Pea, 1988; in Ragan & Tillman, 1998). To effectively apply ICT teachers would need to integrate the tools within an instructional framework that included strategies for generalization and transfer of knowledge, skills and attitudes across contexts. Teachers would also need to implement strategies for orientation, training, scheduling and monitoring. During orientation teachers would have to explain the purpose of the activities and procedures and rules to be followed, and train students in the use of hardware and software. In addition, teachers would need to ensure equitable access for all, through scheduling, and monitor student progress during implementation of the program to ensure that goals were being achieved.

The task of integrating ICT with traditional classroom activities is effectively a new pedagogy for many teachers. This could be attributed to a discontinuity between the learning environments in which teachers themselves were students, and the demands imposed upon the learning environments in which they are now teaching. Further, the teacher's role, according to Graham and Martin (1998), is one that has been evolving from that of an authoritative transmitter of knowledge to that of a co-learner and facilitator. Graham and Martin recommended changes in pedagogical practices that would generate a transformation from the outmoded, broadcast learning model of the past to an interactive learning model. An interactive model is one in which teacher and student work in collaboration as learning is applied to authentic situations (McInerney,
Thus learning no longer centres around the transfer of knowledge from teacher to student, but comes about, instead, through student inquiry, critical thinking, and problem solving, based on information accessed from a variety of sources (Heinich et al., 2002; Maddux et al., 2001; Scheffler & Logan, 1991).

The mid-90s had seen the rapid expansion of the WWW, transforming a disconnected technology into a network facility, and computers evolved into wireless and portable digital assistants. The accompanying changes in pedagogy, however, appeared to have been far less dramatic (Oliver, 2005). If ICT tools were to support the skill sets required in a future world, then the challenge for teachers would be to redesign their instructional frameworks and use the tools to provide intellectually challenging learning experiences within social constructivist contexts. Further, the teacher’s role had evolved from an authoritative transmitter of knowledge within an outmoded broadcast model, to that of co-learner and facilitator within an interactive model (Graham & Martin, 1998). An interactive model is one in which teacher and student work in collaboration as knowledge is applied to authentic situations and learning takes place within a social constructivist context, through inquiry, critical thinking and problem solving based on information accessed from a variety of sources (Heinich et al., 2002; Maddux et al., 2001; Robyler, 2004).

Although earlier research had noted teacher negativity towards computers, more recent studies have reported a gradual increase in teacher support of technological innovation (Yelland, Richardson and Russell, 1997). This was evident in a study undertaken in Year-7 and Year-8 classrooms in schools in Victoria by Fitzgerald et al. (1996). Those researchers reported that teachers were positive about using computers to support both, skill development and complex learning processes across the curriculum. Other research has also reported that teachers have been gaining confidence in the potential of computer technologies as tools to enhance teaching and learning (Wheatley, 2004; Whetsone & Carr-Chellman, 2001; Williams & Price, 2000).
Since implementing a new pedagogy requires skill, creativity, and time, the challenge for teachers has been that of bridging the gap between an awareness of the potential of ICT, and successful practical application of the tool in classrooms. The important implication seems to be that teachers need to be encouraged and inspired to alter their goals and change their views of themselves not only as teachers but also as learners (Schrum et al., 1997). Teachers must also be assured that computers will not replace them but can, instead, empower them. Finally, teachers must be supported in their efforts to acquire the skills and confidence required to make the necessary pedagogical changes to integrate ICT effectively in their instructional programs to support and enhance teaching and learning (Newhouse, 2001).

### 2.7.1 Support for Teachers

The critical factor in integrating ICT is the manner in which the teacher, as facilitator and manager of learning, integrates the resource to achieve curricular and pedagogical goals. However the introduction of ICT into classrooms has occurred largely on an ad hoc basis, relying to a considerable extent on the goodwill and voluntary efforts of teachers (Kerans, 2005; William & Price, 2000). While there had been an increasing focus on the importance of teacher performance and why it matters in terms of teacher readiness, perhaps the most valuable part of the education equation was overlooked, that of professional support for teachers in terms of time in which to plan and experiment with ICT, adequate resources to enable them to apply the tools, and professional development to equip teachers with the skills and confidence required to successfully apply an ICT approach (Ashman & Elkins, 2005; Robyler, 2004).

Crucial to effective integration of ICT is the need for teachers to be able to experiment with ICT, adapt the tools to their preferred pedagogies, plan strategies to integrate ICT activities effectively into instructional frameworks, and organize their classrooms to accommodate the tools. To this effect, teachers would have to gain skills and confidence, not only in the operational use of computer hardware and software, but also in the tasks of interpreting curriculum documents, and designing, managing and evaluating instructional frameworks to ensure that students achieve their goals. Further,
rapid advances in computer technology have made specification of skills a moving
target. For teachers this means ongoing research, and review and update of skills to keep
up with continuing technological advances. Undoubtedly those factors will impact on
teachers’ time and workload.

Contemporary research reinforces the view that, in many schools, teachers continue to
give up their own time. Further, teachers often learn computer skills either at their own
expense or informally from their colleagues (Kerans, 2005). Duncombe & Armour
(2004) found that a lack of time was perceived as being the biggest barrier by teachers.
The need for adequate hardware and software resources has also been a recurring theme.
In addition, to successfully implement an ICT approach teachers would have to be
provided with opportunities to participate in effective professional development, and
allocation of timetabled release to practice new skills.

Although the research literature outlines the characteristics of effective professional
development (PD) and identifies the benefits of school-based professional development,
few workable models exist. Consequently, teachers have floundered in their efforts to
initiate innovative change (Fitzgerald, Hughes & Fitzgerald, 1996; Graham & Martin,
Researchers (Fitzgerald et al. 1996; Newhouse, 2001) argue that traditional approaches
to PD were often unsuccessful because they were narrowly directed toward developing
teachers’ technical knowledge and skills in the use of computers. To make PD
experiences relevant and effective, schools would need to radically alter their priorities,
processes and structures (Duncombe & Armour, 2004).

In order to become confident, critical and creative users of ICT teachers would need
access to PD programs that enabled them to have multiple skills, both, in the use of
technology and in task design. PD would have to not only provide teachers with a
perspective on the operational use of computer hardware and software, but also focus on
skills involving the use of computer-based tools to support learning. Teachers would
need to understand the rationales for integrating ICT tools into traditional instruction, and be able to interpret curriculum documents to make decisions pertinent to designing, delivering, managing and evaluating instruction (Graham & Martin, 1998). The transfer of these new skills to pedagogy is dependent upon the attitudes and experiences of individual teachers (Williams & Price, 2000).

Contemporary literature on PD for teachers asserts that a skills-based, expert model of PD is not the most effective in engaging teachers in ICT use and that a focus on learning and pedagogy would be more productive (Holmes et al. 2002). Learning experiences that apply directly to the classroom would be more valuable to teachers and more sustainable (Holmes et al. 2002). While staff development programs may begin with skills based training, the programs should then progress to assisting teachers to develop as professionals involved in decision making, inquiry, and leadership in classroom teaching.

Professional Development programs would also need to accommodate the principles of adult learning (Castner, 1998). Paramount among those is the notion that adults are best motivated to learn when they can take responsibility for their own learning and promote their own methodological and attitudinal changes, progressing through a developmental change process (Wesley & Franks, 1996). That change process addresses the issues of emotional support, technical assistance, instructional sharing and collaboration. From those perspectives, computer integration involves not just the acquisition of technical skills and resources but the challenging of deeply held beliefs, attitudes, perceptions, and experiences with regard to teaching methods and pedagogy as it is not ICT but the manner in which the tools are integrated within the classroom context that will determine successful implementation of the tools (Godfrey, 2001, b).

The Teacher Learning Technology Competencies document (Williams & Price, 2000) underscored the importance of making onsite professional development available for teachers. The document recommended that training be directed towards the goals of
schools with situated models and positive reinforcement and support (Williams & Price, 2000). It was also recommended that teachers be allowed to choose from a range of learning experiences to meet their own particular need or to support a desired change in their teaching practice. (Hickson, Blackman & Reis, 1995; Lindsey, 2000; Olson & Platt, 2000).

Teachers have encountered challenges in their efforts to integrate ICT in classrooms. Three of those challenges, addressed in this review, are ones that have been most commonly identified in the literature. A lack of time was perceived as being the biggest barrier by teachers, and in many cases teachers have continued to learn to use ICT in their own time and at their own expense (Kerans, 2005). The lack of adequate hardware and software resources for classroom use was also found to be a challenge for many teachers. Researchers also expressed the importance for relevant professional development to equip teachers with the skills and confidence required to successfully apply an ICT approach to meet the needs of students in the contemporary classroom (Ashman & Elkins, 2005; Robyler, 2004).

2.8 Summary

The findings of this review have a number of implications for educational practice. To this degree, research undertaken across educational levels and learning areas demonstrate that when ICT is used in programs that are well designed and supported by teachers the tools have the potential to enhance student achievement outcomes. Research also demonstrates that ICT has desirable effects on student attitudes, promotes learning within social constructivist contexts and has the potential to improve the quality of the learning environment, leading to sustained engagement and more meaningful learning opportunities for students.

Traditionally, computers had been used in classrooms as a tool for drill-and-practice, for tutoring, or for delivering instruction and conveying information (Edwards, Norton, Taylor, Wies & Van Dusseldrop, 1975). When used solely in this manner, information is stored in the software and student interaction can often consist of simply pressing a
key to continue a presentation of information or to respond to queries posed by the software, limiting meaningful control of the learning process. In a gradual paradigm shift in school education during the past decade, there has been an emphasis on the quality of learning experiences for students rather than just quantifiable outcomes (Cotton, 1997; King, 1997; Godfrey, 2001b). Computer technologies are now being described as powerful information and communication (ICT) tools that, when used within well designed instructional frameworks, have the potential to reshape the educational process, sustain motivation and engagement, improve social skills and promote students’ sense of ownership of the learning process (Cuban, 2002; Squires, Morton & Brown, 1997).

Although researchers support the notion that ICT can enhance students’ achievement outcomes and attitudes, they caution that computers can be counterproductive when used in a theoretical vacuum. The most desirable outcomes are obtained when computer-based tools are used as part of a holistic approach rather than solely for drill and practice or for isolated activities. And while both, traditional and computer-based tools have valuable roles in supporting instruction, they produce the best results when complementing one another in the classroom, as part of a holistic approach.

The new millennium has seen the development of an array of exciting new ICT tools that have the potential to support teaching and learning in the emerging inclusive classroom, and to enhance learning experiences within social constructivist contexts. However successful integration of ICT calls for new teacher skills and attitudes, and flexible pedagogical approaches. This requires support for teachers, in terms of time in which to plan, experiment and implement ICT, adequate hardware and software resources, and relevant professional development (Ashman & Elkins, 2005; Robyler, 2004). Further, researchers assert that even when ICT is effectively integrated in classrooms, teachers need ongoing organisational support to sustain that process.
The task of effectively integrating ICT tools in schools ultimately rests on the actions of school policy makers, administrators, and most importantly, teachers. At the system level policy makers can work towards providing solutions to address school ecology by examining the assumptions propelling reform through ICT. At the administrative level leaders can support teachers by respecting their expertise, paying attention to their working conditions and professional needs, and involving them in planning processes surrounding the use of ICT. At the classroom level, teachers can lead the way by exploring and implementing new ways of integrating ICT tools to support teaching and learning, by reflecting on their own practice, and challenging their pedagogical beliefs. How can this collaborative approach be an enabler for reengineering classrooms for the digital age? This is the critical question to be addressed by the project. This begs the question that I need to reiterate which is embedded in the research questions that will drive this thesis. The next chapter will describe the methodology applied in this study.
CHAPTER THREE
Research Methodology

3.1 Introduction: The Brief
This study set out to evaluate the effectiveness of ICT on student achievement outcomes in Reading Comprehension, Reading Vocabulary and Mathematics, in comparison with the use of traditional classroom instruction alone. The study was also intended to highlight the management, organizational and pedagogical issues associated with the use of ICT in the primary classroom, and the skills and support structures required for teachers to enable them to effectively integrate ICT into traditional classroom activities. Outcomes of such a study would inform schools, and more specifically teachers, when making decisions pertinent to the use of ICT in the primary setting.

3.2 The School Context
In initial meetings between the researcher, the school principal and the Year-4 teachers it became apparent that there were some conditions under which the study would have to be conducted. Computers were being introduced in Year-4, and the school was in the process of examining a range of models that could be used to support the integration of ICT in Year-4 classrooms and in other primary classrooms. To this effect the school principal requested that two Year-4 teachers and their students be involved in the study. This direction would afford the capacity to view the project alongside existing structures. It was also the school’s intention that on completion of the study, the Year-4 teacher participants would apply their new skills and experiences and assume a mentoring role to assist other teachers as the school extended its initiative to integrate ICT in other primary classrooms.

There could be only minimal intrusion upon the manner in which the school operated. This directive meant that classes and timetables could not be redesigned. There could be no change in routine, students would have to be rostered around the existing timetable,
and the Year-4 teachers would manage and organize students’ access to ICT as part of their regular classroom instruction.

The constraints were looked upon, not as a challenge but as an enabler that provided an opportunity to investigate the use of ICT tools in what is a typical situation in schools and classrooms. From the researcher’s perspective, the manipulation of the ICT variable was of relevance, so minimal disruption to normal routine would actually work in favour of the investigation from a quasi-experimental perspective. Taking into consideration the constraints imposed on the study, a design was then devised for the investigation.

3.3 Design and Instrumentation

Based on the discussions with the principal and teachers, designs that would best implement the research questions within this context were examined. The approach that was deemed most appropriate to answer the research questions pointed towards a Case Study within which would be embedded a quasi-experimental pre-test/post-test/control group design, plus a control group for the pre-test effect. This design was ultimately selected because it controlled for most of the threats to validity (Tuckman, 1999).

A decision was made to apply a combination of quantitative and qualitative methodologies within the case study. This decision was based upon experience gained from a study conducted by the researcher in 1998, and one conducted by Fitzgerald, Hughes and Fitzgerald in Victorian schools in 1996 (Fitzgerald et al., 1996). The framework for data collection was then formulated to keep the process both manageable and flexible without diminishing the quality of data obtained. Specific quantitative and qualitative methodology procedures were then devised to answer the research questions.
Research procedures were conducted across four phases (Fig 3.3). At the commencement of Phase One, students were invited to participate and letters were sent to parents explaining the purpose of the study and the procedures to be applied, and parental consent was obtained. Teachers engaged in ICT training sessions held by the researcher. Students were randomly assigned by their teachers to either the treatment group or the control group. As part of quantitative methodology pre-tests were administered to students in the treatment and control groups in Reading Comprehension, Reading Vocabulary and Mathematics. Students also completed an attitude questionnaire as part of pre-study procedures.

In Phase Two, students in the treatment group participated in orientation and training sessions facilitated by their teachers. Following orientation and training, students in the treatment group engaged in ICT activities as part of their English and Mathematics instruction. Data were collected from student and teacher participants using qualitative methodology. During this time students in the control group engaged in traditional instruction alone.

In Phase Three, post-tests in Reading Comprehension, Reading Vocabulary and Mathematics were administered for quantitative analysis. Students also completed the attitude questionnaire as part of post-study procedures.

In Phase Four, qualitative data collection procedures took place. Following an analysis of data, a summary of preliminary research findings was presented to the principal, and participating teachers, students and parents. Student and teacher participants were then debriefed.
Prestudy Procedures:
- Invitation to school
- Invitation to teachers

Phase 1:
- Invitation to students
- Permission from parents
- Training for teachers
- Teachers assign students to the treatment or the control group
- Collection of quantitative data: Administration of pre-tests and attitude pre-questionnaire to treatment and control groups

Phase 2:
- Student orientation, training and scheduling
- ICT activities used as part of English and Maths instruction
- Collection of qualitative data: Student logs Weekly teacher meetings

Phase 2:
- Students engage in traditional activities during English classes
- Students engage in traditional activities during Maths classes

Phase 3:
- Administration of post-tests to treatment and control groups
- Attitude post-questionnaire to treatment and control groups
- Administration of post-tests to second control group

Phase 4:
- Final data collection
- Student post-interviews
- Teacher post-questionnaire

Post study procedures:
- Final analysis
- Preliminary findings presented
- Debriefing

Outcomes

Fig 3.3 Design and Instrumentation: Overview
3.4 Quantitative Data: Collection and Analysis

Quantitative methods of data collection were used to determine the effectiveness of ICT on student achievement outcomes in Reading Comprehension, Reading Vocabulary and Mathematics, and on student attitudes towards learning.

3.4.1 Student Achievement

To investigate differences in student achievement outcomes, pre-tests and post-tests were conducted in Reading Comprehension, Reading Vocabulary and Mathematics. Pre-test and post-test scores of the treatment group were compared with those of the control group using inferential and descriptive statistical analysis.

To control for pre-test effect and to further enhance the validity of the study design, post-tests (only) in Reading Comprehension, Reading Vocabulary and Mathematics were administered to an additional control group. This group was drawn from a Year-4 class that had not previously participated in the study.

Selection of tests. Progressive Achievement Tests (PAT) developed by the Australian Council for Educational Research (ACER, 1997) were used to measure student achievement in: (1) Reading Comprehension, (2) Reading Vocabulary, and (3) Mathematics. Upon seeking advice from the Australian Council for Educational Research (ACER), a decision was made to administer the tests in parallel formats: Format-A for pre-tests and Format-B for post-tests. Parallel formats were selected to ensure that extraneous variables, i.e. pre-testing experience, maturation and academic progression over time, would not influence student achievement scores (ACER, 1997).

The PAT Reading Comprehension tests were designed to measure two major aspects of reading skill; factual and inferential comprehension of prose material. The PAT Reading Vocabulary tests were designed to measure word knowledge and interpretation of prose material. PATMATHS tests were designed to provide information in relation to the level of achievement attained by students in skills and understandings of Mathematics (ACER, 1997). PATMaths tests include a range of general mathematics topics that were
assigned to an appropriate outcome from the Mathematics ‘National Profiles’ (Curriculum Corporation, 1994). Questions match outcomes appropriate to Year levels, and closely reflect curriculum emphases and coverage of the strands (ACER, 1997).

**Data Analysis.** In addition to descriptive statistical analysis, it was proposed that independent t-tests be performed on pre- and post-test data in Reading Comprehension, Reading Vocabulary and Mathematics. Independent t-tests would be used to examine mean differences between student scores on tests administered prior to the application of ICT and following the treatment. Quantitative data were analysed using *SPSS for Windows Version II.*

### 3.4.2 Student Attitudes

To identify and compare student attitudes towards learning, students from the treatment group and control group completed an Attitude questionnaire prior to the application of ICT and following the treatment. The SAME questionnaire was applied for pre- and post-procedures. The questionnaire afforded an opportunity to collect a great deal of data in the available timeframe.

The Attitude questionnaire contained 30 items intended to measure the dimensions of self-esteem, attitudes towards learning, and attitudes towards computers. A Likert Scale was used, with a rating of 1 to 5; 1 indicating that the scale was least favoured, and 5 indicating that the scale was most favoured. The questionnaire was based on an instrument developed by Fitzgerald, Hattie and Hughes (1985) for a national project, funded by the Commonwealth Department of Education, and was used by Fitzgerald et al. (1997) in a research project funded by the NSW Ministry of Education. This questionnaire was selected because it had previously been used to measure affective responses in relation to students’ involvement with information technology. A copy of the Attitude questionnaire is located in (Appendix 8).

The questionnaire, administered in pre-test mode, contained additional survey questions that were included to gather data in relation to students’ computer skills and experience.
Additional survey questions are located in Appendix 9. The questions were framed in open response form and sought information on existing student knowledge and skills relating to the use of computers. It was considered that student responses might be relevant in adjusting the training program that was devised by the researcher, in collaboration with the teachers.

**Data Analysis.** Independent t-tests were performed on the Attitude scale to identify and compare student attitudes towards learning prior to the application of ICT and following the treatment. Quantitative data on the Attitude scale were analysed using *SPSS for Windows Version II*.

### 3.5 Qualitative Data: Collection and Analysis

Qualitative data were collected from the students and teachers to explore classroom management, organisational, and pedagogical issues associated with the use of ICT. Based on the work of Creswell (1998), and on the researcher’s perceptions of issues associated with the use of ICT, it was decided that data pertaining to classroom management, organization and pedagogical issues could be best collected through student logs, work samples, interviews, teacher meetings, teacher questionnaire and observation schedules.

**Student logs.** Each week two students (in total) were randomly selected by their teachers to complete a log. Students responded to four questions that were used in the log (Appendix 10). The questions were used as scaffolds to assist students record their feelings and views in relation to the use of computers. Data collected through the logs were useful for identifying issues associated with the use of ICT and provided ongoing information from student perspectives.

**Work samples.** Teachers collected work samples each week from a randomised cross-section of students. Work samples were an effective way in which to supplement other sources of data obtained from students. Collection of work samples did not add to the teachers’ workload since all students were required to compile copies of their work in
individual portfolios for purposes of assessment and accountability as part of the regular classroom procedures undertaken each day.

**Student interviews.** During the post-treatment phase, four students (in total) from the treatment group were randomly selected to participate in semi-structured interviews. Students were interviewed individually for approximately 15 minutes, and were asked to respond to 4 open-ended questions pertaining to their use of ICT and their perception of its usefulness in their learning (Appendix 11). Semi-structured interviews enabled students to identify issues and discuss their views and experiences freely.

**Weekly teacher meetings.** Weekly meetings were held by the researcher, during which the teachers discussed classroom issues associated with the use of ICT. During these meetings the researcher recorded the salient points of each discussion. The meetings afforded flexibility and gave teachers the opportunity to share their ideas, experiences and concerns, reflect on their methods, and make collaborative decisions relating to ICT activities and teaching strategies. As part of the procedures, teachers completed a checklist to evaluate the teaching program (Appendix 13). Meetings lasted no longer than 15 minutes and the time and place were arranged to suit the teachers.

**Pre- and Post- Teacher questionnaire.** The teachers were invited to complete a questionnaire prior to and following the treatment period, to identify changes in their perceptions towards ICT. This method was less intrusive in terms of teachers’ time and afforded an opportunity to collect a great deal of data in the available timeframe. Further, teachers were able to complete the questionnaire at their convenience. The SAME questionnaire was used for pre- and post- procedures (Appendix 12).

**Observation schedules.** Weekly observation schedules were conducted once a week by the researcher to gain first hand information on a range of issues and events associated with the use of ICT in the natural setting of the classroom as the study unfolded (Sample Observation Schedule located in Appendix 14).
3.6 Implementation

The study was structured to be implemented in four phases, outlined in a Design Overview located in Fig 3.3. This structure best reflected the stages involved in the treatment, the administration of pre-tests, post-tests, questionnaires and qualitative data collected through other means. Prior to Phase One the teachers and the researcher engaged in discussion and planning pertaining to the teaching program. As part of that process an instructional framework, within, which ICT was integrated, was formulated. A training plan for students was also devised. The four phases were:

1. Administration of pretests for quantitative assessment of Reading Comprehension, Reading Vocabulary, and Mathematics; administration of Attitude questionnaire prior to treatment.

2. Application of ICT in the classroom (treatment) and collection of qualitative data.

3. Administration of Reading Comprehension, Reading Vocabulary and Mathematics post-tests, and Attitude post-questionnaire for quantitative assessment and comparisons of student groups.

4. Final data collection, through informal student post-interviews and teacher questionnaire for qualitative assessment.

3.6.1 Phase One

Administration of Pre-tests

Phase One commenced in February 2001. A letter from the school principal was sent to parents of Year-4 students, explaining the purpose of the study and procedures to be undertaken, and requesting permission for students to participate. A consent form was attached to the letter, to be completed and returned by parents should they wish their
child to participate. A letter from the researcher was also sent to parents explaining the reason for the study and the procedures to be applied (located in Appendix 3 & Appendix 4).

On obtaining parental permission, Year-4 student participants were randomly assigned by their teachers to either a treatment group or a control group. Thus there were 24 students in the treatment group, 12 from each Year-4 class, and 24 students in the control group, 12 from each Year-4 class. Following assignment to groups, students were briefed by their teachers on procedures involved in the study using a Student Dialogue Sheet (located in Appendix 5).

**Administration of pre-tests.** The researcher administered pre-tests, to students in the treatment and the control group, in Reading and Mathematics using ACER PAT Reading Comprehension and Reading Vocabulary, and PATMaths tests in Format-A. The tests were conducted, over two days, in the Year-4 classrooms and students were supervised by their class teachers.

**Attitude questionnaire.** As part of Phase one procedures, an Attitude questionnaire was completed by the students in the treatment and control groups. The time allocated for completion of the questionnaire was 20 minutes. A copy of the Attitude questionnaire is located in Appendix 8.

**Teacher training.** The Year-4 teachers attended four training sessions, conducted by the researcher in the use of the hardware and software to be integrated. The duration of each session was determined by the individual needs of the teachers, one of whom required more assistance than the other, having had limited prior experience in the use of computers.
3.6.2 Phase Two

Application of ICT: Classroom Management and Organisation

In Phase Two, students in the treatment group used ICT tools as part of their English and Mathematics instruction for two terms. During this time students in the control group continued with traditional activities during English and Mathematics instruction. The two Year-4 teachers assumed their normal teaching roles and managed and facilitated traditional and ICT activities. A teacher aide, who was in paid employment, assisted students with special support needs, from both, the treatment and control groups. The researcher conducted classroom observation twice per week (Appendix 14), chaired the weekly research and reflective teacher meetings, and assisted with technical advice if the teachers encountered a problem.

Six computers were located in the multi-purpose area (MPA), just outside the Year-4 classrooms. Concertina doors opened up to the MPA to enable teachers to supervise students seated inside the classroom, and those seated at the computers in the MPA. The computer area was screened off from the rest of the MPA to minimize distraction. Software and hardware resources used by students and teachers are listed below. A more detailed explanation is contained in Section 1.2.1, and in Fig 1.2.1.

Software resources:

- MS Word
- MS PowerPoint
- MS PhotoEditor
- Reading for Literacy
- Computer Classroom for Maths

Hardware resources:

- Six Personal computers
- Printer
- Digital camera
**Student orientation.** One 30-minute orientation session was held by the teachers. During the session, the teachers explained the purpose of ICT activities, and rules and procedures to be followed when accessing computers. Students were placed by their teachers, in learning groups of four and were rostered to access the computers either individually for tasks or in groups for collaborative projects. Each student was provided with an activity box that was placed on shelves next to the computers. Each box contained a floppy disk, cardboard folder, an ICT Training Progress Card (Fig 3.6.2), and an ICT Activity Card (Fig 3.7). Rules, procedures and rosters were displayed on large laminated posters on the wall above the computers.

**Student training.** Six 20-minute sessions were scheduled for student training. During training sessions students learned to manipulate software and practised basic computer skills including mouse skills, keyboard skills, word processing, and procedures for printing and saving documents. A flexible approach was applied to enable students to progress at their own pace. Training was conducted as a paired activity using demonstration, peer support and cue cards which were laminated and displayed next to each computer. Cue cards contained lock-step instructions and were colour coded to reflect specific procedures.

An ICT Training Progress Card, located in Fig 3.6.2.a, was maintained for each student. The teachers documented computer skills as they were achieved by each student, using a rating scale of 1 to 5. A rating of 4 or 5 indicated that the student had fully grasped a specific skill, a rating of 1, 2 or 3 indicated that the student was developing the skill. Teachers used the computer competency progress cards to track student progress and to their guide decision making in relation to activities and group placement. Students who had not achieved a specific skill, particularly slower learners, were either supported by peers or given additional training. Additional time was also given to enable those students to practice skills they had not mastered.
**ICT TRAINING PROGRESS CARD**

<table>
<thead>
<tr>
<th>Sessions completed</th>
<th>Mouse skills</th>
<th>Keyboard skills</th>
<th>Word processing editing</th>
<th>Using Reading Literacy CD</th>
<th>Using Computer Classroom Maths CD</th>
<th>Using Digital software</th>
<th>Using MS PowerPoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
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<tr>
<td>Session 2</td>
<td>1 2 3 4 5</td>
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<tr>
<td>Session 3</td>
<td>1 2 3 4 5</td>
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<tr>
<td>Session 4</td>
<td>1 2 3 4 5</td>
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<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Level of Achievement: Developing skill = 1 ___ 2 ___ 3 ___ 4 ___ 5 ___ = Achieved skill

**Fig 3.6.2.a ICT Training Progress Card**

**Scheduling.** Students from both, the treatment and control group were organized in learning groups of four to work on collaborative activities. Students who used ICT (treatment group) were grouped together, and those who used traditional instruction alone (control group) were grouped together. Six computers networked to a printer, were set up in the Multi-purpose area (MPA) outside the Year-4 classrooms. Two small portable screens were used to screen the computer area in the MPA. Concertino doors separating the classrooms and the MPA were opened up when students accessed computers. This enabled teachers to supervise and assist students from the treatment and control groups.

Students from the treatment group were rotated to access the computers either individually or in groups, and followed a roster that was displayed on the wall in the computer area. Students access to computers is detailed below:

**Individual Activities:**
- Reading practice = 2x20mins per week
- Maths practice = 2x20mins per week
- Publishing/Writing = 2x20mins per week

**Group Activities:**
- Digital & Multimedia projects = 2x30mins per week per group
During the time that students in the treatment group accessed computers, those in the control group continued with traditional English and Mathematics activities.

**Monitoring.** Before each interaction with ICT students were required to mark their name off the roster, set a timer for their allocated time, and log onto the computer using their password. For each session students were required to place a cross on their activity card indicating that they had accessed the computer. At the end of each ICT session students were required to save their work onto a floppy disk, print a paper copy of their work, and then log off the computer. Students were to discuss and edit their work with the assistance of a group member and then see the teacher who marked and dated their work. The printed copy was placed in the student’s cardboard folder, to be edited and reprinted at the next ICT session.

During the next ICT session students edited their work on the computer and saved and printed the final copy which was placed in the student’s portfolio to be marked by the teacher. On completion of each ICT interaction the teacher placed a stamp on the student’s ICT Activity Card and added a written comment in the comment column (Fig. 3.6.2.b). This enabled teachers to monitor and keep track of student progress, and to access student work for assessment.

<table>
<thead>
<tr>
<th>Day</th>
<th>Individual: Writing/Publishing (20mins)</th>
<th>Individual: Reading practice CD (20mins)</th>
<th>Individual: Maths practice CD (20mins)</th>
<th>Group: Digital &amp; Multimedia (30mins)</th>
<th>Teacher comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>11 to 11.20</td>
<td>1.30 to 2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td>10 to 10.20</td>
<td>9 to 9.20</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wednesday</td>
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<tr>
<td>Thursday</td>
<td>11 to 11.20</td>
<td>1.30 to 2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td>10 to 10.20</td>
<td></td>
<td>9 to 9.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Individual Activities:**
- Reading practice = 2x20mins per week
- Maths practice = 2x20mins per week
- Publishing/Writing = 2x20mins per week

**Group Activities:**
- Digital & Multimedia projects = 2x30mins per week per group

Fig.3.6.2.b ICT Activity Card
At the conclusion of each English and Maths lesson all students discussed their progress in a whole-class *discussion circle*. On completion of each project, products were showcased by the students, marked by the teacher and then displayed in the classroom.

Throughout Phase Two qualitative data were collected through observation, student weekly logs and weekly teacher meetings. The data were used to identify classroom management, organizational and pedagogical issues associated with the integration of ICT.

### 3.6.3 Phase Three

**Administration of Post-tests for Comparison between Groups**

Phase Three procedures were conducted at the end of Term 2. As part of those procedures, post-tests were administered over two days. Students from the treatment and control groups completed ACER PAT Format-B tests in Reading Comprehension, Reading Vocabulary, and Mathematics.

Students from the treatment and control group also completed the Attitude questionnaire a second time. Results from the second application of the Attitude questionnaire were compared with those from the first application to identify changes, if any, in attitudes following the application of ICT.

Students from an additional control group, drawn from a Year-4 class that had not previously participated in the study, also completed post-tests using ACER PAT Format-B in Reading Comprehension, Reading Vocabulary, and Mathematics. This direction was taken as part of post-study procedures to rule out for pre-test effect and so further enhance the validity of the study design.
3.6.4 Phase Four

Final Data Collection for Qualitative Assessment

To complete Phase Four, data were collected for qualitative assessment through student interviews and teacher questionnaires.

**Student interviews.** Four students from the treatment group were randomly selected by their teachers to participate in an interview with the researcher. Students were interviewed individually for approximately 15 minutes, and responded to questions pertaining to the use of ICT and their perception of its usefulness in their learning (Appendix 11). During the interviews student input was recorded by the researcher.

**Teacher questionnaire.** The teachers were invited to complete a questionnaire on their perception of ICT as classroom tools, and issues associated with the application of ICT in the classroom (Appendix 12).

Subsequent to final collection of qualitative data, post-study procedures were undertaken for the final analysis and debriefing. In addition, a summary of initial findings was presented to the school principal, teachers, students and parents.

3.7 Conclusion

This chapter detailed the research design and quantitative and qualitative methodologies used for collection of data from students and teachers. The classroom procedures used for integrating ICT with traditional activities were also outlined. The following chapter contains the quantitative and qualitative outcomes of the study.
CHAPTER FOUR

Findings

4.1 Introduction
Based on the evidence collected from quantitative and qualitative data, a number of positive outcomes from the research process emerged in this investigation. Those outcomes have been organized in two main sections; quantitative outcomes and qualitative outcomes.

4.2 Quantitative Outcomes: Student Achievement and Attitudes
To make comparisons between achievement outcomes of students in the treatment group and those in the control group, quantitative data was collected through pre-tests and post-tests in Reading Comprehension, Vocabulary and Mathematics. Independent t-tests were performed on the scores to test for significance of mean differences between student scores before and after the application of ICT.

To identify and compare student attitudes towards learning, students from the treatment group and control group completed an Attitude questionnaire prior to the application of ICT and following the treatment. The SAME questionnaire was applied for pre- and post- procedures.

4.2.1 Reading Comprehension
Student Reading Comprehension levels were measured twice using ACER Progressive Achievement Tests (PAT). Format A served as a pre-test while Format B was used as a post-test. Student mean scores on those tests are displayed by group and by test in Fig 4.2.1.
Student mean score in the treatment group improved from 16.20 in the pre-test to 26.00 in the post-test, while student mean score in the control group rose from 15.08 in the pre-test to 18.00 in the post-test. Thus overall, students in both groups improved in their Reading Comprehension. However, achievement outcomes of students in the treatment group improved significantly more on average than students who undertook traditional instruction alone ($t_{46}=3.8, p<0.001$).

4.2.2 Reading Vocabulary
Student Reading Vocabulary levels were measured twice using ACER Progressive Achievement Tests (PAT). Format A served as a pre-test while Format B was used as a post-test. Student mean scores on those tests are displayed by group and by test in Fig 4.2.2.
The mean score of students in the treatment group improved from 21.46 in the pre-test to 35.00 in the post-test, while student mean score in the control group rose from 18.62 in the pre-test to 23.50 in the post-test. Thus overall, students in both groups improved in their Reading Vocabulary. However, achievement outcomes of students in the treatment group improved significantly more on average than those of students who undertook traditional instruction alone ($t_{46}=4.7, p<0.001$).

### 4.2.3 Mathematics

Student Mathematics levels were measured twice using ACER Progressive Achievement Tests in Mathematics (PATMATHS). Format A served as a pre-test while Format B was used as a post-test. Student mean scores on those tests are displayed by group and by test in Fig 4.2.3.

![Maths](image)

**Fig 4.2.3 Mean score: Treatment group & Control group**

The mean score of students in the treatment group improved from 21.79 in the pre-test to 30.83 in the post-test while student mean score in the control group rose from 22.12 in the pre-test to 24.04 in the post-test. Thus overall, students in both groups improved in their Mathematics based on the improvement in mean scores. However, achievement outcomes of students in the treatment group improved significantly more on average than students who undertook traditional instruction alone ($t_{46}=5.25, p<0.001$).
4.2.4 Student Attitudes

To identify and compare student attitudes towards learning prior to the application of ICT and following the treatment, students from the treatment group and the control group completed the SAME Attitude questionnaire before and after the treatment. Independent samples t-tests were used to compare student mean scores on the Attitude scale. Student mean scores on those tests are displayed by group and by test in Fig 4.3.

![Attitudes graph]

Fig 4.3 Mean score of Treatment group & Control group

On the attitude scale, the mean score of students in the treatment group improved from 94.50 in the pre-questionnaire to 115.95 in the post-questionnaire, while student mean score in the control group rose from 94.70 in the pre-questionnaire to 95.00 in the post-questionnaire. Overall, student attitudes in both groups improved. However, attitudes of students in the treatment group improved significantly compared with attitudes of students in the control group ($t_{46}=4.34$, $p<0.001$).

4.3 Comparisons with Post-test Control Group

To rule out for pre-test effect, post-tests in Reading Comprehension, Reading Vocabulary and Mathematics were administered to students from an additional control group from a Year-4 class. This group had not previously participated in the study. Independent samples t-tests were used to compare achievement outcomes of students from the control group with achievement outcomes of students in the post-test control group.
4.3.1 Post-test Comparison in Comprehension

Comparison of mean scores on the Reading Comprehension post-tests revealed a result of 17.91 for students in the control group and 17.12 for students in the post-test control group. Student mean scores on the post-tests are displayed by group and by test in Fig 4.4.1. A simple comparison of means suggests no difference between the groups ($t_{46}=0.48$, $p<0.64$).

![Comprehension Graph](image)

**Fig 4.4.1** Post-test: Control group & Post-test group

4.3.2 Post-test Comparison in Reading Vocabulary

Comparison of mean scores on the Reading Vocabulary post-tests revealed a result of 23.50 for students in the control group and 24.00 for students in post-test control group. Student mean scores on those tests are displayed by group and by test in Fig 4.4.2. No difference was found to exist between the groups ($t_{46}=-0.28$, $p<0.79$).

![Vocabulary Graph](image)

**Fig 4.4.2** Post-test: Control group & Post-test control group
4.3.3 Post-test Comparison in Mathematics

Comparison of mean scores on the Maths post-tests revealed a result of 24.05 for students in the control group and 24.54 for students in the post-test control group. Student mean scores on those tests are displayed by group and by test in Fig 4.4.3. No difference was found to exist between the groups ($t_{46} = -0.35, p<0.73$).

![Mathematics](image)

Fig 4.4.3 Post-test: Control group & Post-test control group

4.4 Qualitative Outcomes

Qualitative data collection methods included student logs, student interviews, work samples, teacher meetings, teacher post-questionnaire, and researcher observation. Based on evidence from the data collected, a number of positive outcomes were noted. Those outcomes have been categorised to reflect student and teacher perceptions, under the headings; student perceptions of ICT, student concerns, teacher perceptions of ICT, and teacher concerns. A discussion of findings is contained in Chapter 5.

4.4.1 Student Perceptions of ICT

An analysis of qualitative data collected from students indicated that, in the main, students were very positive about their interaction with ICT. According to students ICT activities had helped them in reading, writing and Maths. Student perceptions have been articulated below.
Opportunities to improve in reading and writing. There were a number of positive comments from students with regard to the use of writing and publishing tools. Student 1 remarked, “the computer software helped me to read better, and I did not feel nervous while I was reading”. Student 2 said, “when I used the computer for writing it was easy to edit my work, I did not have to write it again”. Student 3 stated, “my work looked neat and I used pictures to make it interesting”.

A non-threatening environment. Student 4 commented, “I liked the reading activities on the CD because when I made a mistake in reading other students did not know, I clicked on the speaker the computer did the reading for me. It was easier for me to understand and find answers to the questions”. Student 3 said, “Book was a funny cartoon character on the CD who helped me and gave me the instructions. Each time I clicked on Book the instructions were repeated until I could understand what I had to do”.

Opportunities for improvement in Maths. The students commented enthusiastically about using the interactive Maths activities. Student 2 said “I liked the maths activities, they were fun, like playing games”. Student 4 said, “the maths program was fun to use and it helped me to learn how to solve problems. I am improving in my maths and I got better marks in my class test”. Student 3 commented, “I am beginning to understand maths better now”, and, “I liked doing the activities on the CD on measurement, I am finding it easier to do maths”.

Motivation and engagement through interactive software and games. Students found both the interactive CDs easy to use, helpful, and interesting and remained engaged during their activities. Student 4 stated, “we were told by the computer when we were wrong and we received help until we learned how to do the problems and got the correct answers, then we were able to try again and get a better score”. Student 2 excitedly exclaimed, “the cartoon characters were unreal and helped me to learn in a fun way”.

Opportunities to enhance social constructivism. Students stated that using ICT in their group projects was fun, and remarked, “we liked group work and we liked taking photos
using the camera and using photos in our projects, it was interesting”. Students also stated, “when we worked in our group we were learning how to take turns and how to get along with others”.

4.4.2 Student Concerns

When asked about what they liked the least about ICT activities students stated that there were some aspects they did not like. Student concerns are listed below.

Maths activities were sometimes too long and students sometimes could not quit the software until they had reached the end of an activity. That is, the student interaction period was determined by the software. Student 4 remarked, “the CD would not let us quit and we sometimes had to ask our teacher to help us to quit”.

Multimedia and digital activities. Multimedia and digital presentations were time consuming and students felt that they were not given enough time to complete their presentations. According to Student 2, “it was fun using the camera but when we were putting the images together and adding text we needed more time to finish our work”.

Technical problems associated with the printer. The printer was slow and sometimes did not work. Student 2 remarked, “we were disappointed when we could not print our work and we sometimes had to wait until the next day for a copy”.

Despite their concerns, students reported that the interactive sessions on the computer made learning fun. Students also expressed a desire to continue to use ICT to help them to enhance their presentations and to improve their skills in reading, writing, and to help them to improve their skills in Mathematics.

4.4.3 Teacher Perceptions of ICT

The teachers reported that, when used in combination with traditional instruction ICT, had the potential to support the learning and teaching process. ICT made it possible for teachers to plan and implement a variety of learning activities and individualise learning
particular to learning needs and learning styles. The teachers’ perceptions have been articulated in more detail in the following sections on classroom management and organization, pedagogical issues, and teacher concerns.

### 4.4.4 Classroom Management and Organisation

According to the teachers, many aspects of classroom management and organisation were similar to those applied when implementing traditional learning activities. However, there were some aspects that required additional time and effort. The teachers stated, “it took time to plan an instructional framework that integrated ICT into instruction, and to evaluate and modify the program as an ongoing strategy. It also took time to become familiar with the features of the software ourselves prior to planning and implementing our program”.

The teachers commented that in order to maximize the benefits of ICT it was essential to train students in the use of software. Students had to be scheduled to ensure that they could access software equitably and benefit from their interaction with ICT. In addition, students had to be assisted when they encountered technical problems, and monitored carefully to ensure that they worked within time constraints, completed tasks, and remained focused on their learning goals.

The teachers believed that careful forward planning and ongoing evaluation and adjustment were crucial to effectively manage and organize a classroom that integrated ICT. Teachers were also of the view that planning should include a number of alternative strategies and activities in case there were unexpected disruptions in computer use.

### 4.4.5 Pedagogical Issues

Teachers found that a combination of type 1 and type 2 tools was useful to support a number of pedagogical features of instruction and individualise instruction to meet a range of student needs, including needs of lower achievers and those of high achievers.
Precise pedagogical features are listed below and are discussed in more explicit detail in the next chapter.

*Constructivism and social constructivism.* Students worked in teams, to actively collaborate with ICT and with each other to construct and assemble new knowledge; linking multimedia, digital and traditional activities to solve a central problem which culminated in a project. According to teacher A, “the students were very excited about taking photographs and using PowerPoint as part of their class work”. A list of collaborative projects and activities is contained in Fig 4.4.5.

<table>
<thead>
<tr>
<th>Collaborative projects combining enactive, iconic and symbolic activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Create a multimedia report on the planets. Gather information from various sources and prepare a PowerPoint presentation. Include dimensions of each planet and their distance from earth</td>
</tr>
<tr>
<td>o Make a diorama of the solar system using craft materials. Measurements must be to scale. Photograph your diorama and prepare a multimedia report.</td>
</tr>
<tr>
<td>o Create large papier mache models of the planets using balloons, newspaper. Paint the planets and set up your model of the solar system in the quadrangle. Measurements must be to scale.</td>
</tr>
<tr>
<td>o Earth is heading for destruction from a giant asteroid. You and your group of scientists have been given the task of re-colonising a planet. Make a list of the major survival needs for a small colony. What will you call your planet. Select 50 members of society you will select for your colony. State reasons. Select 10 animals you will take. State reasons. What food and other items will you take. Draw a map of your new city. Devise 10 laws. Work out costs of the project.</td>
</tr>
<tr>
<td>o Write a procedure for cooking damper. Cook the damper and photograph the process. Create a PowerPoint presentation of the process using photographs. Provide exact measurements of the ingredients used, cooking time and oven temperature.</td>
</tr>
<tr>
<td>o Make a super sandwich using the procedure from the poem ‘Super sandwich’. Photograph the process. Create a PowerPoint presentation of the process using the poem and photographs.</td>
</tr>
<tr>
<td>o Create a poster advertising a holiday on the moon. Include costs for travel, food and other expenses. Provide total expenses.</td>
</tr>
<tr>
<td>o Create a board game using jeopardy questions about the planets. Include 2 or 3 Maths questions.</td>
</tr>
<tr>
<td>o Describe your holiday on the moon, from the time you left earth upto the time of your return. Prepare a table with a list of your expenses, work out the total costs for a family of four.</td>
</tr>
<tr>
<td>o Create a crossword on the planets using 10 or more clues. Include dimensions of at least 2 planets, and their distance from earth.</td>
</tr>
<tr>
<td>o Write a story about a trip to the moon, how long did it take to get there and why.</td>
</tr>
<tr>
<td>o Make a poster presenting a timeline on space discoveries.</td>
</tr>
<tr>
<td>o Write a rap song about the planets. Use numbers for one of the verses.</td>
</tr>
<tr>
<td>o Make up a list of 20 spelling words on the planets to test your peers.</td>
</tr>
<tr>
<td>o Plan a holiday on the moon. Include costs for travel, food and other expenses. Provide the total cost of the holiday for a group of five friends.</td>
</tr>
</tbody>
</table>

*Fig 4.4.5 Examples of collaborative projects and activities*
Enactive, iconic and symbolic learning experiences. By combining traditional, practical and ICT activities in their instructional framework the teachers were able to provide an environment within which students could engage in enactive, iconic and symbolic learning experiences. Teacher B stated, “through this approach we were able to address student diversity and cater for the needs of high achievers, low achievers, and those with specific learning needs” (Bruner, 1966; Dale, 1969). More detail pertaining to enactive, iconic and symbolic learning experiences are contained in Fig 4.4.5, in Section 5.5, and in Fig 5.5.

Scaffolding. Interactive activities contained in Computer Classroom for Maths were used to scaffold students in their efforts to grasp new concepts and skills in Maths. This was of great benefit to students particularly for lower achievers. Activities in Reading for Literacy were used to treat specific skills and increase student confidence in reading comprehension and vocabulary. Teacher B said “the speech capabilities of the software took over some of the burdensome task of decoding for slower readers, enabling the reader to concentrate on other aspects of reading and comprehension”. Worksheets and traditional classroom activities were used to reinforce new skills.

Increased confidence in reading. The teachers used the interactive software Reading for Literacy, selecting lessons and activities to treat reading problems specific to individual students. Teacher A commented “the units included a variety of fiction and non-fiction text types and we were able to focus on text types that were in our program. Each lesson treated a specific reading skill. This made the task of individualization and targeting specific needs, easier.” Teacher B remarked, “Slower students were able to proceed at their own pace as they interacted with software activities that were targeted to their needs to reinforce understanding of concepts and to practice new skills. On the other hand we were able to use lessons that were more challenging to extend the skills of high achievers”.

Increased confidence in writing. Used as literacy tools, word processing and publishing software made students more confident to express their ideas freely without
having to focus too much on structure and language. Teacher A stated, “students were able to edit their work and enhance their presentations at a later stage without having to undertake re-writes”. Students were more willing to take risks and to be creative when expressing their ideas textually as they gained an understanding of the structural aspects of targeted text types, specifically; recounts, reports and procedures.

*Increased motivation and engagement.* Teachers noted an increase in motivation and engagement in ownership of the learning process when students accessed ICT. Teacher A remarked, “students displayed a desire to complete their work and enhance the quality of their final presentations, they were reluctant to log off the computers and put away their work at the end of lessons and at recess and lunch time”.

*Practice in meaningful contexts.* ICT activities that included digital imaging and multimedia tools enabled students to work towards a goal within a meaningful context and create solutions in real situations. Teacher 2 reported that, “students got a real buzz when they were required to cook a damper, photograph the process, combine a digital and textual presentation of the procedure and to then share the damper for morning tea”.

*Multimodal representation and communication.* Finally, and most importantly, multimedia and digital tools enabled students to interact with new knowledge and create and represent their learning in a variety of ways. The teachers stated that “students were able to represent and communicate their learning in a variety of ways that were specific to their abilities and learning styles”. Digital photography enabled students to capture learning experiences as they were occurring. Viewing the experiences, documented in digital imaging gave students opportunities to reflect on their experiences and reinforce their understanding.

**4.4.6 Teacher Concerns**

Although several benefits were reported, the teachers also expressed some concerns regarding the use of ICT. Those concerns are listed below and are discussed in more detail in Chapter 5.
Disruptions caused by network problems or viruses. The teaches stated that “disruptions made it difficult for students to continue with their work and stay focused”. When they were unable to proceed with ICT activities, students completed other aspects of their projects or engaged in alternative traditional or paper-based activities.

Student training was time consuming. This was true particularly for a small number of students who found it difficult to manipulate software features effectively and for those who worked at a slower pace. Teacher A stated, “we were able to overcome this difficulty through peer support and cue cards. However, we had to occasionally help these students during lunchtime”.

Some ICT activities were time consuming. Since most computer interactions were achieved using mouse clicks, this slowed down progress for students who found it difficult to manipulate the mouse, particularly in the early stages of implementation. According to the teachers, “students for whom this was a problem were given additional time to practice specific skills”. Two activities on the Maths software locked students into a sequence. The teachers discontinued those activities.

Changes in school routine. Unexpected changes in routine sometimes impacted on set schedules and resulted in shortened lessons. Teacher A said, “this was sometimes problematic, and although we used a cross-curricular approach to manage time constraints it was sometimes difficult to complete activities”. In such instances activities had to be re-scheduled, adjusted or completely discarded.

Students were distracted by multimedia functions. Students sometimes became distracted by multimedia functions and game-like qualities of the software. The teachers reported, “we used incentives such as merit cards and weekly team awards to keep students focused. Collaborative activities also helped to keep students focused as they helped and encouraged each other”.
Meeting deadlines. This was sometimes difficult because multimedia and digital activities were time consuming. Teacher B stated, “group projects enabled students to support each other and draw on the strengths of the group. However it was essential to implement structures to facilitate ICT use and monitor students to ensure they remained engaged and worked to deadlines”. A cross-curricular approach made more time available for students to complete tasks.

Interruptions by students. Teacher A said, “we were sometimes interrupted when students found it difficult to manipulate software or access the printer”. The teachers occasionally sought advice from the researcher. To minimize interruptions a decision was made to use peer support and students who were proficient in ICT use were appointed to assist others when a problem arose.

4.4.7 Teacher skills and Attitudes
To effectively implement ICT within an integrative approach teachers need to be motivated to upgrade their skills and feel empowered to take risks and experiment with ICT, and to foster that empowerment in their own students. Teacher participants were willing to develop and enhance their skills in the use of ICT, working collaboratively to integrate the tools and ensure that classroom goals were achieved by all students. To effectively apply ICT teachers integrated the tools, using strategies for generalization and transfer of knowledge, skills and attitudes across contexts. Teachers also implemented strategies for orientation, training and scheduling. In addition, it was necessary for teachers to monitor student progress, during implementation of the program, to ensure that goals were being achieved.

4.4.7.1 Support for Teachers
In this study teachers were supported by the researcher who assisted teachers in becoming familiar with software, helped in planning an ICT approach, and offered teachers technical advice when required. The teachers also worked collaboratively and supported each other. Thus, a shift from a skills based approach to a practical, team-
based approach was initiated to support teachers’ professional learning within the classroom context, with a focus on integrating ICT into units of work using a cross curricular approach.

4.5 Conclusion

This chapter reported on quantitative and qualitative outcomes of the investigation. According to quantitative data, students who had used ICT as part of their instruction in English and Mathematics achieved higher outcomes compared with students who had used traditional instruction alone. There was notedly more improvement in the attitudes of students who had used ICT as part of their instruction compared with students who had used traditional instruction alone. An analysis of qualitative data revealed a number of significant findings in relation to classroom management and organization and pedagogical issues. The next chapter contains a discussion of findings.
5.1 Introduction
This discussion has been organized under the sections; student achievement, student attitudes, classroom management and organization, and pedagogical issues, teacher concerns and teacher skills and attitudes.

5.2 Student Achievement
Quantitative outcomes indicated that students who had used ICT as part of their instruction in English and Maths improved more in Reading Comprehension, Vocabulary and Maths compared with students who had used traditional instruction alone. Those findings reinforce assertions by Fitzgerald et al., (1996) and Newhouse (2001) that when computers are used within instructional frameworks that are well designed and supported by teachers, the tools can improve student achievement outcomes. Outcomes also indicated other positive benefits for students who had used ICT as part of their instruction. Students were willing to learn more and used their time more productively, and teachers were able to focus on teaching creatively and on assisting those students who required more assistance than others, suggesting that ICT tools have the potential to enhance the teaching and learning process (Newhouse, 2001).

5.3 Student Attitudes
Student attitudes to learning are crucial because attitudes reflect their academic progress and achievement in the classroom. Findings in this study revealed that there was more improvement in attitudes of students who had used ICT compared with attitudes of students who had used traditional instruction alone. A number of positive qualitative outcomes were also noted including enthusiasm for learning, ownership of the learning
process, increased motivation, and the desire to complete work and enhance the quality of final presentations. The usefulness of computers to enhance the quality of learning environments and, consequently, improve student attitudes towards learning has been well recognised (Fitzgerald et al., 1996; Funkhouser, 1993; Newhouse, 2001).

Using ICT to support learning, teachers were able to create an environment in which students were intrinsically motivated, enthusiastic and remained on task (Beck & Fetherston, 2003). The importance of the physical setting has been emphasized by many theorists. According to Piaget, children acquire knowledge by interacting with the environment and learning takes place as the student interacts with peers and adults within the social setting (Piaget & Inhelder, 1969). Positive experiences can empower learners and is an important factor that can determine a student’s attitude and promote motivation.

**5.4 Classroom Management and Organisation**

There is a perception that ICT tools can run themselves (Gleghorn, 1993; in Ragan & Tillman, 1998) However, learning that occurs in isolation is not sustained in other contexts (Pea, 1988; in Ragan & Tillman, 1998) and while ICT can offer opportunities to enhance teaching and learning, the success of such an approach was dependent upon the teachers who managed and organized the classroom to accommodate the tools. The teacher participants stated that most aspects of classroom management and organization were similar to those used when implementing traditional learning experiences (Fatouros et al., 1994; Fitzgerald et al., 1996). However, there were aspects that required additional time and effort. Those included training students in the use of software, scheduling students to access ICT, and monitoring students to ensure that they stayed on task and achieved their goals. There was also the task of planning and evaluating the program and modifying and adjusting traditional and ICT activities in response to student needs to ensure that all students were successful in reaching their goals.
5.5 Pedagogical Issues

In this study ICT was integrated within a social constructivist context, resulting in a number of pedagogical benefits for students. However, this was facilitated by teachers who were willing to engage in forward planning, to manage and organize their classes using the approach, and to make adjustments to their teaching program during implementation, in response to student needs. The pedagogical dimensions of computer-based tools had been given increasing attention since the 1990’s. Reeves (1994; in Lidstone & Lucas, 1998) defined such dimensions as those capabilities of technology that can be used to initiate powerful instructional interactions, monitor learning progress, and accommodate individual differences. The teachers stated that a combination of type 1 and type 2 tools enabled them to support a number of pedagogical features of instruction and individualise teaching to meet a range of student needs, those of lower achievers through to the needs of high achievers.

Type 1 tools were useful for targeting and treating specific skills. The interactive multimedia activities in Reading for Literacy-4, were useful particularly for developing students’ skills in reading comprehension and vocabulary. Teachers were able to select from a comprehensive range of activities and target text types that matched curriculum, and treated specific reading skills. Printable worksheets included in the package were useful for reinforcing newly acquired concepts. The interactive activities contained in Computer Classroom for Maths Level-4 were useful to reinforce key learning skills and to assist students’ in their understanding of mathematical concepts. The activities on the CDs enabled students, particularly low achievers, to develop and practice important skills and concepts that they could use when pursuing higher order activities (Forcier, 1999; Robyler, 2000).

Other benefits in the ICT approach included immediate feedback, motivation, nonjudgemental correction and time saved for teachers who were then able to focus on teaching in creative ways (Maddux et al., 1999). In the past, educationalists had been critical of type 1 tools because they were badly designed, the activities were repetitive and boring, and there was a tendency for teachers to overuse the tools (Forcier, 1999;
O’Brien, 1994). However, there are many contemporary examples of well-designed software built on the foundation of random generation, quality feedback and controlled navigation that can effectively reinforce learning and motivate learners, particularly low achievers (Forcier, 1999; O’Brien, 1994).

Writing and publishing software, multimedia and digital tools are open-ended and so could be flexibly applied by the teachers within an integrated instructional framework, and within a social constructivist context (Cotton, 1996; Dowling, 1999; Maddux, 2001; Robyler & Edwards, 2000). This type of software provided active intellectual involvement, placing students in control of almost everything that happened on the screen, shifting the focus from the computer to students who determined when and how to use the computer to support their efforts in obtaining and presenting information. Students also had greater control over their interaction with the computer, deciding when to use the spell checker, thesaurus and sound and editing features.

The word processor supported a range of activities, writing strategies and styles and took the drudgery out of composing, revising and processing text. As a result, students found writing a pleasurable and satisfying activity, particularly the reluctant writers. Using features of the word processor, students were able to complete writing tasks one step at a time, planning, organizing and composing in non-linear format, and editing words and ideas until they had achieved the desired effect (Dowling, 1999; Robyler & Edwards, 2000).

Multimedia provided students with opportunities to use different modes of representation, and to develop and enhance individual expression of ideas in a variety of ways through the integration of text, graphics, diagrams and photographs. The digital camera and software enabled students to document field trips and practical activities, thus adding greater description and unique perspectives to their representations. Students were able to reinforce their learning by viewing a record of their learning experiences on the computer screen. Such description, insight and individuality would be difficult to convey within a single media format. The flexible capabilities of the tools made it
possible for students to edit textual and multimedia material and re-arrange their ideas and sequencing of ideas (Bottge & Hasselbring, 1993).

The teachers fostered *social constructivism* by organizing students to work in teams using ICT. Thus students interacted with ICT and with each other within an intellectual environment in which they constructed new knowledge by modifying and building on existing knowledge, through exploring, creating, decision making and representing new knowledge (Jonasson et al., 1998; McInerney, 2002). Within such contexts, learning experiences are student controlled, supported by teachers. Students felt that learning was their responsibility when they were involved in planning and decision making (McInerney, 2002).

Units were built around projects instead of being based on topics as can occur in traditional approaches. This meant that emphasis was given to specific problems, as a basis for learning. Within the projects the teachers provided focused teaching as students explored a problem and came up with solutions. Through the process of investigating and solving a specific problem, students worked collaboratively towards a goal to create solutions that were meaningful to them (McInerney, 2002). Results from group investigations were used to produce multi-media presentations, paper-based products, and craft products. Supported by multimedia tools students were able to achieve their goals which culminated in a product. The advantage of using a problem-based approach in instructional design made it possible for students to work at a level appropriate to them, and to be assessed against their performance that reflected results based on abilities (Onasko & Jorgenson, 1998).

There is a paucity of research that addresses what is a critical aspect of classroom learning, the nature and quality of the interaction between teacher and student, and between student and student. Contrary to concerns that computers may reduce the level of social interaction between student and student and, and between teacher and student, a high level of peer interaction was noted during ICT activities. As students worked in groups, expressing their understanding of concepts and problems and teaching each
other new skills, they used the dynamics of the group to raise the level of creativity, working together to complete their task, providing positive reinforcement to each other and learning how to cooperate. Such contexts are also successful because they facilitate reflection (McInerney, 2002).

Theories concerning enactive, iconic and symbolic learning experiences such as those proposed by Bruner (1966) and Dale (1969), have been given attention, particularly in the teaching of young children and those with learning needs. The use of a variety of ICT activities made it possible for teachers to embody those concepts within their instructional framework (Fig 5.5). Students combined text, graphics and digital imaging to enhance their representations, using multimedia tools. Enactive experiences were found to be time consuming and decisions had to be made continually in relation to trade-offs between the ‘concreteness’ of learning experiences and what was realistically possible, given time constraints.

![Fig 5.5 Enactive, iconic and symbolic experiences](image-url)
Scaffolding. Teachers ‘placed’ students within the ZPD Vygotsky (1978) by using interactive and multimedia capabilities of ICT to scaffold students. As scaffolds, interactive software provided students with opportunities to practice and improve essential key learning skills which were reinforced through written work and traditional activities. Interactive software *Computer Classroom for Maths* was used to scaffold students in their efforts to grasp and reinforce new concepts and skills in Maths. The boys, in particular, found the game-like qualities of the lessons engaging and were eager to access the software, reinforcing Riddle and King’s views (1997) that, when implemented effectively, ICT can meet diverse needs, making learning an exciting adventure instead of a ‘dreaded chore’. Written and practical activities were used to reinforce students’ Maths skills and understanding.

*Increased confidence in reading.* Teachers selected activities from *Reading for Literacy* to assist students in improving essential key literacy skills and to increase their confidence in reading. The construction of meanings and negotiations occur before, during and after reading and writing events, and comprehension levels improve as students interact and transact with texts (Rosenblatt, 1978). Speech capabilities of the software took over the burdensome task of decoding for slower readers. This enabled that group of students to concentrate on other aspects of reading such as construction of meaning (Rosenblatt, 1978; Ruddell & Ruddell, 1995). According to the teachers, the units included a variety of fiction and non-fiction text types and they were able to select text types to match the program. Each lesson treated a specific reading skill. This made the task of individualizing sessions easier for teachers. Students’ skills were supported and reinforced further through traditional oral and written tasks.

*Increased confidence in writing.* When students found that they would be able to edit their work without having to undertake re-writes, they became confident and presented their ideas more freely, consequently, writing longer and better texts (Dowling, 1999). They were able to organize their ideas more coherently when they reviewed their text. Further, to use the word processor effectively in the writing process, students were
required to maintain intellectual involvement, user control, and user control of interaction with the machine (Robyler & Edwards, 2000).

Multimedia features of *PowerPoint* motivated students during the writing process, particularly reluctant writers who remained engaged as they worked to combine text and images to create a presentation as part of their group project. Multimedia presentations can be challenging because they include not just the conceptualising of various media but also the creation of links between segments of material to create the structure of hypertext. Additionally, dynamically presented information concerns the degree of control offered to students who decided to what extent the user would manipulate sounds and images, pause, go backward or forward, halt the sequence, or end the activity. Planning and producing multimedia products was a critical component of the design and implementation process and provided for further development of collaborative skills in students (Brown, Darcy & Robinson, 2003).

*Increased motivation and engagement.* The computer has been described as an effective tool in motivating and engaging students (Brown et al., 2003). Teacher participants reported increased motivation and engagement, enthusiasm for learning and ownership of the learning process. Students displayed a desire to complete their work and enhance the quality in their final presentations. The process of learning is a challenge for every student, especially those who have experienced frustration and failure. ICT offered many opportunities for students to engage in various literacy activities including reading, writing, speaking, listening, drawing and discovering (Riordan & Karlsson, 1996).

*Practice in meaningful contexts.* Digital imaging and multimedia tasks supported students in their efforts to work collaboratively to complete their group projects and achieve their goals. Photographs added another dimension to their multimedia activities. Students were able to record their own experiences and products in contexts within which they were participants. As they reviewed and shared their Powerpoint
presentations with other groups they reinforced their own learning and the learning of their peers and engaged in reflective processes (Riordan & Karlsson, 1996).

*Multimodal representation and communication.* Multimedia tools also provided students with opportunities to represent their ideas and increase description. Students were able to display unique perspectives, interests and skills that were difficult to convey in a single media format (Dowling, 1999). Furthermore, in the implementation of their representations, students participated in peer collaboration through which they engaged in varied cognitive thinking strategies within an atmosphere of high motivation (McInerney, 2002).

From qualitative findings, it was evident that student engagement was high and the quality of their work improved. Students were more willing to spend time on their activities, and were enthusiastic about completing and enhancing their presentations. Some frustration did occur when there were disruptions and students could not complete their work. There will, doubtlessly be constraints with an ICT approach. However this can be overcome when teachers are willing to replace rigid practices with flexible programs (Newhouse, 2001).

### 5.6 Teacher Concerns

Several pedagogical benefits were reported by the teacher participants. However, the teachers also expressed concerns associated with managing and organising an ICT approach. Training was time consuming, particularly for those students who worked at a slower pace. They were supported through peer support, cue cards, and extra time to practice skills. In addition, some ICT activities, particularly multimedia authoring activities were time consuming.

Disruptions caused by network problems or viruses also made it difficult for students to continue with ICT activities and stay focused. Interruptions by students when they encountered technical difficulties impinged on teacher time. This occurred more
frequently in the initial stages of the study. Changes in school routine were also problematic. In such instances activities were adjusted or postponed since teachers were willing to use a flexible approach and adapt the teaching program to accommodate such occurrences (Cuban, 2001). The teachers also managed the issues by using a cross-curricular approach which meant that more time was made available for students to complete tasks. Incentives were also used to keep students focused and peer support was applied to trouble-shoot technical difficulties. In addition, group projects enabled students to support each other and draw on the strengths of the group (McInerny, 2002).

5.7 Teacher Skills and Attitudes
As a result of this study, several issues have been identified in relation to teacher skills and attitudes. While ICT can support learning and teaching, teachers must be in a position to understand how the technologies can be used to enhance learning and be willing to adapt the tools to their preferred pedagogical approach (Cuban, 2001). Implementing a new pedagogy requires skill, creativity, and time. The challenge for teachers has been that of bridging the gap between an awareness of the potential of ICT, and successful practical application of the tool in classrooms.

The important implication seems to be that of encouraging and inspiring teachers to alter their goals and change their views of themselves not only as teachers but also as learners (Schrum et al., 1997). Teachers must also be assured that computers will not replace them but can, instead, empower them. In addition, teachers must be supported in their efforts to acquire the skills and confidence to make the necessary pedagogical changes required to use ICT effectively to support and enhance learning and teaching (Newhouse, 2001).

5.7.1 Support for teachers
As this study has demonstrated, among principal elements that can help teachers to integrate ICT into their classrooms are training in software use, assistance with planning the integrative instructional framework, and onsite technical advice and guidance. There also needs to be a more co-ordinated and collaborative effort based on a common vision
and a commitment to specific objectives, combined with reflection for teachers who implement an ICT approach (Mosley et al., 1999). Contemporary literature on professional development (PD) for teachers also asserts that a skills-based, expert model of PD is not the most effective in engaging teachers in ICT use and that a focus on learning and pedagogies that apply directly to the classroom would be more valuable to teachers and more sustainable (Holmes et al. 2002).

5.8 Conclusion
This chapter contained a discussion of findings in relation to student achievement, student attitudes, classroom management and organization, and pedagogical issues. By adapting ICT to meet individual and diverse student needs, teachers were able to use ICT to support new and different ways of teaching and learning and as a result, enhance student achievement outcomes and attitudes (Heinich et al., 2002; Maddux et al., 2001; Mann, 2000; Ritchie, 1999). The following chapter contains a conclusion and recommendations for further research.
CHAPTER SIX

Conclusion

6.1 Introduction

This study was devised primarily to seek answers to the following research questions:

1. Does the use of ICT tools by Year-4 students in treatment groups result in higher achievement outcomes in English and Mathematics, compared with the achievement outcomes of Year-4 students who receive traditional classroom instruction alone?

2. Does the use of ICT tools by Year-4 students in treatment groups improve their attitudes towards learning and towards themselves as learners, compared with the attitudes of Year-4 students who receive traditional classroom instruction alone?

3. What are the classroom management, organisational, and pedagogical issues associated with the use of ICT from student and teacher perspectives?

4. Do teachers need new skills and altered attitudes to be empowered to integrate ICT effectively in their classrooms?

Although a small study, the conclusions that have been drawn in accordance with the findings have important implications for primary schools and classroom practitioners and for future research.

6.2 Summary of Findings

Quantitative and qualitative findings are summarised in relation to (1) student achievement outcomes in Reading Comprehension, Reading Vocabulary and
Mathematics, (2) attitudes of students after the integration of ICT, (3) management, organisational and pedagogical issues associated with the use of ICT, and (4) teacher skills and attitudes required to integrate ICT tools effectively in classrooms.

Student achievement. Students who used ICT as part of their English and Mathematics instruction, improved significantly more on average in Reading Comprehension, Reading Vocabulary and Mathematics compared with students who used traditional instruction alone. The findings are consistent with those reported in a number of research projects in the literature. Those studies reiterate that when ICT is used in educational programs that are well designed and supported by teachers, the tools have the potential to enhance student achievement outcomes.

Student attitudes. Overall, student attitudes in both groups improved. However, attitudes of students in the treatment group improved significantly compared with attitudes of students in the control group. Positive attitudes included student ownership of the learning process, increased motivation, and the desire to complete work and enhance the quality of final presentations, all critical in contemporary learning theory.

Management and organization. The success of an ICT approach requires teachers, as managers and organisers of learning, to use the tools to assist, motivate, and capture and sustain student enthusiasm for learning. In this study teachers were willing to plan and implement an approach that linked traditional and ICT activities with curriculum content, and to modify, adapt, and assign learning experiences as required, within the demands of the classroom.

Pedagogical issues. ICT was used to support a number of pedagogical features of instruction within a social constructivist context (McInerney, 2002). Those features included scaffolding, enactive, iconic and symbolic learning experiences, individualization, meaningful contexts, and motivation and engagement. To make this possible, teachers engaged in collaborative forward planning to integrate ICT activities
with traditional classroom learning experiences, monitored and modified those experiences, evaluated aspects of planned experiences, and reflected on implications for future planning. Those strategies are implicit in effective teaching practice (Robyler, 2002).

Teacher skills and attitudes. The skills, experiences and perceptions of teachers impact on the learning environment. Hence the extent of the benefits of ICT tools is dependent upon teacher skills and attitudes, for it is not ICT but the manner in which teachers integrate the tools into their instructional frameworks that will ensure the success of the approach. The integration of ICT in classrooms is still a relatively new and complex process that is better understood when examined contextually. As Johnson (1998) reiterates, this task is more than just acquiring a set of technical skills, competencies and physical resources. Teachers must also have an understanding and an acceptance of the need to change current pedagogy, and be willing to forego their power base within the classroom in order to meet the changing needs of students. This disposition can be seen as threatening within our ageing teaching force. In this study teachers were accepting of the need to alter pedagogy and were willing to work collaboratively and flexibly to implement ICT.

Support for teachers. If ICT tools are to be successfully applied in classrooms teachers must be supported in their efforts to develop the skills and attitudes, and to make the pedagogical changes required. Among principal elements that can be used to support teachers are training in software use, assistance with planning the integrative instructional framework, and technical advice. Contemporary literature also asserts that a focus on pedagogies that apply directly to the ICT supported classroom would be valuable for teachers and more sustainable. Teachers must be provided with time and opportunity to reflect on their current practice and pedagogical beliefs with a view to realising preferred aims for teaching and learning within a technology-supported learning environment.
6.3 Recommendations

It is envisaged that the following recommendations could maximise the potential of ICT as tools to enhance teaching and learning within an integrated instructional framework in the inclusive classroom.

**Recommendation 1.**
That teachers extend the potential of desktop publishing and multimedia software through the integration of those tools across all areas of the curriculum.

**Recommendation 2.**
That teachers explore and evaluate software tools that can be used to improve knowledge, skills and understanding of students with learning difficulties particularly in the literacy area.

**Recommendation 3.**
That teachers apply flexible strategies to increase computer access for all students. This may be a system requirement, and as such, beyond the capability of the teacher.

**Recommendation 4.**
That teachers who use ICT within an integrated approach be provided with technical support, physical resources, time for program planning and time to become familiar with new software resources.

**Recommendation 5.**
That professional development and support structures be explored, so that teachers can be supported by programs that encourage and inspire them to alter their pedagogical goals and become more in tune with the educational implications of technological innovations in contemporary education.
6.4 Conclusion

Given that this study demonstrates 1) desirable effects on student achievement outcomes and attitudes, and 2) a number of pedagogical benefits for students, there are several interesting avenues for further research involving the use of ICT as tools to enrich the inclusive setting. In this study, the teachers were supported by the researcher who assisted with planning the instructional framework, and with technical advice. The teachers worked as a team to find solutions to problems and to make adjustments in the teaching program in response to student needs. This is indicative of collaborative teaching and learning which is empowering to reflective teachers (Pollard, 2002).

In conclusion, the key to engaging teachers in the successful integration of ICT is to understand how they can be supported in their professional learning, and how they can adapt their pedagogies and embrace change. Increased efforts in research are warranted to support progressive development of higher standards of teaching, and attitudes of wholeheartedness and open-mindedness (Pollard, 2002).

“Open-mindedness is an active desire to listen to more sides than one, to give heed to facts from whatever source they come, to give full attention to alternative possibilities, and to recognize the possibility of error even in the beliefs which are dearest to us” (Dewey, 1933, p.29).
6.5 References


Board of Studies NSW (1994). K-6 English Syllabus. Published by Board of Studies NSW: North Sydney.


Lindsey, J.D. (2000). Technology and exceptional individuals. Austin, TX: Pro-Ed.


Reading for Literacy 4 [Computer Software]. (2001). Warners Bay NSW: Nightingale Software Pty Ltd.


Human Ethics Review Committee Approval

The University of Western Sydney Penrith

Protocol No: HE99/125
APPENDIX 2

Schedule of Tasks for Study

Pre-study Procedures:
1. Invitation to schools
2. Invitation to teachers
3. Program Planning

Phase 1:
1. Invitation to students and letter to parents
2. Written permission from parents
3. Training for teachers
4. Teachers assign students to the treatment group or the control group
5. Teachers brief students on study procedures
6. Administration of pre-tests and attitude pre-questionnaire to treatment and control group

Phase 2:
1. Student orientation and training
2. Students in treatment group engage in ICT activities as part of English and Maths instruction
3. Collection of qualitative data: Student logs, Teacher logs, Observation, Meetings with teachers
4. Students in control groups engage in traditional activities in English and Maths classes

Phase 3:
1. Administration of post-tests to treatment group, control group and second control group
2. Attitude post-questionnaire to treatment group and control group

Phase 4:
1. Final data collection
2. Student interviews
3. Teacher Questionnaire

Post-study Procedures:
1. Debriefing procedures
2. Preliminary analysis
3. Report preliminary findings to school principal, teachers, students and parents
4. Final analysis
5. Write thesis
APPENDIX 3

Principal’s Letter to Parents of Student Participants
Researcher’s Letter to Parents of Student Participants
Student Dialogue Sheet

Prior to the study, student participants were briefed on study procedures by their class teacher. The following dialogue sheet was used for the briefing.

“Students,

Your class has been chosen to participate in a study to find out whether computers are useful in learning and how they can be used in your classroom. This study will also help teachers and other students with information about computers.

You will be given three tests in English and Mathematics before and after the study. You will also be asked to fill in a Questionnaire. The tests will take place in your classroom with your own teacher present.

During the study there will be lessons as usual in the classroom. Computers will be used in the classroom for part of your instruction.

Participation in the study is completely voluntary and there are no disadvantages or penalties for not participating. You may take part in the study if you wish. Your parents have also been informed and have consented to your participation in the study. If you decide not to participate, or you decide to withdraw from the study at any time, you may do so and you will not be disadvantaged in any way. If you decide not to participate on a particular day, you will not be made to complete the task and you will not be disadvantaged in any way.

At the end of the study you will receive a summary of the results of the study. Should you have any questions, your teacher will answer them and provide you with further information”.
ACER Progressive Achievement Tests (PAT) in Reading Comprehension and Reading Vocabulary
APPENDIX 7

ACER Progressive Achievement Tests in Maths (PATMATHS)
# Student Attitude Questionnaire

Student number: ______
Date: _________
Place a tick in only one of the columns under 1, 2, 3, 4 or 5
1= Agree very much
2= Agree a fair amount
3= Agree a little
4= Disagree a little
5= Disagree very much

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APPENDIX 9

Computer Survey for Treatment Group

(Responses to the following questions were used to guide students’ training sessions)

Student name: ______
Date: ______

Please answer the questions in two or three words:

Have you used a computer before? __________

If you have a computer at home please answer these questions:

1. For what things do you use your computer?

________________________________________________________________________

2. How often (each week) do you use the computer for games? ___________________

3. How often (each week) do you use your computer for school work? ______________

4. If you use your computer for school work, describe the kind of work. ____________

________________________________________________________________________
APPENDIX 10

Weekly Log Questions for Students

Two students were randomly chosen each week to respond to the following questions.

1. How did you use the computer this week?
   For Reading:
   For Writing:
   For Maths:

2. What was most enjoyable about using the computer this week?

3. What activities did you enjoy the least?

4. Was there anything about using the computer that disappointed you this week?
APPENDIX 11

Post-Interview Questions for Students

Four students were randomly selected to participate in a post-Interview in Phase 4. Students were asked to respond to the following questions:

1. How did you feel about using the computer as part of your learning?
   - For Reading:
   - For Writing:
   - For Maths:
2. How often did you use the computer each week, and for how long?
3. What did you like best about using computers?
4. What was not very enjoyable about using a computer?
5. Were there any problems that occurred when you used the computers?
6. How do you think the computer has helped you with your Reading? Writing? Maths?
7. Would you like to continue to use computers to help you in your learning?
   - If yes, Why?   - If no, Why not?
8. In what ways would you like to use computers to help you in your learning?
9. Is there anything else you would like to say about using computers?
Teacher Questionnaire

1. What strategies or procedures did you apply that were different when you used computers?

2. Did you change your classroom organisation to apply computers? 
   In what ways?

3. Did using computers make it easier/harder to manage your class? 
   In what ways?

4. How did you organise students to access the computers?

5. Were there any issues with regard to the time allocated to each student for computer use each week? Please give reasons.

6. What was the time commitment required by you in addition to normal classroom hours with regard to:
   (i) Learning to use software
   (ii) Curriculum/Lesson planning
   (iii) Teaching students to use software

7. As a result of using computers:
   (i) The following things were successful:
       Please give reasons.
   (ii) The following things were not so successful:
       Why do you think so?
   (iii) The following things were unsuccessful:
       What do you attribute them to?

Please add anything else you think might help other teachers in the use and integration of computers in the classroom.

Thank you for the time taken to complete this Questionnaire. Your opinion is valued.
# Teaching Program Evaluation Checklist for Weekly Meeting

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<td>The structure of the teaching program is consistent with the content of the course</td>
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<td>Outcomes of the teaching program are clear and precise</td>
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<td>The teaching program is organized in a logical way</td>
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<td>5.</td>
<td>The teaching program provides for knowledge, skills and attitudes outlined in the course document</td>
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<td>6.</td>
<td>The teaching program adequately caters for student needs</td>
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<td>7.</td>
<td>The resources are suitable</td>
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<td>Hardware:</td>
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<td>Software:</td>
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<tr>
<td>Traditional:</td>
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<tr>
<td>8.</td>
<td>The resources are adequate</td>
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<tr>
<td>Hardware:</td>
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<tr>
<td>Traditional:</td>
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<td>9.</td>
<td>The selected assessment procedures are appropriate</td>
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<td>10.</td>
<td>The outcomes of the program evaluation reflect student achievement</td>
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</tbody>
</table>

**Comments:**

Modifications required in relation to:

- Assessment: ________________________________________________________________
- The teaching program: _______________________________________________________
- Teaching strategies: _________________________________________________________
- Resources: _________________________________________________________________
- Hardware: _________________________________________________________________
- Software: _________________________________________________________________
- Traditional: _______________________________________________________________
Sample Observation Schedule

<table>
<thead>
<tr>
<th>Descriptive notes</th>
<th>Reflective notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description of activities and physical setting</strong></td>
<td><strong>Notes about the process, reflection on activities</strong></td>
</tr>
<tr>
<td><strong>Experiences of students:</strong>&lt;br&gt;As they use computers: students appear very excited about their activities on the computers&lt;br&gt;It is difficult to stop the activity at bell time.&lt;br&gt;Teacher presented remedial activities for a small group</td>
<td>It was very rewarding to note the enthusiasm and engagement displayed by the students.&lt;br&gt;Suggested strategy: It may help if pack up time takes place a little earlier and students are cued with a small bell to prompt them to pack up.</td>
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<tr>
<td><strong>Classroom layout and physical setting:</strong>&lt;br&gt;The present physical arrangement of desks, chairs and computers works well</td>
<td>The teachers are able to provide direct and indirect supervision of students as they access computers.&lt;br&gt;Suggested strategy: 6 small additional chairs will eliminate the need for students to move chairs in and out of the classroom</td>
</tr>
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<td><strong>Comments on technical aspects:</strong>&lt;br&gt;One student was having difficulty with the printer&lt;br&gt;Students were still having difficulty with saving their work and asked the teacher for assistance&lt;br&gt;Students having difficulty locating materials</td>
<td>Printer was not plugged in correctly, student sought teacher assistance&lt;br&gt;Suggested strategy: Computers to be organized before classes start&lt;br&gt;Teachers were interrupted by students they were not sure how to save their work.&lt;br&gt;Suggested strategy: Some students may need a revision of procedures</td>
</tr>
<tr>
<td><strong>Problems:</strong>&lt;br&gt;Students were having difficulty with camera, the teacher assisted&lt;br&gt;Students having difficulty focusing and positioning the camera</td>
<td>Suggested strategies: Students may need a revision of and demonstration of procedures&lt;br&gt;Students may need a reminder to ask Technical Assistants (students) for help before approaching the teacher</td>
</tr>
<tr>
<td><strong>Positive behaviours noted:</strong>&lt;br&gt;Students were engaged and very interested in completing their work&lt;br&gt;Frequent occurrence of on-task peer support in the publishing process.&lt;br&gt;Students provided each other with more support at the computers than was observed when they were writing at their desks.</td>
<td>Discussion Circle Students and teacher share their experiences, discuss progress and showcase completed work.</td>
</tr>
</tbody>
</table>
Students worked at their desks and engaged in traditional activities, and individual or group activities.

Students from the treatment group accessed computers in the Multi purpose area.

Concertina screen doors between the classrooms and multi-purpose area were opened up. Teachers were able to supervise those students seated at their desks in addition to those seated at the computers. Students were able to move freely, as required, to undertake various activities.